

ESDM One Map Indonesia Indonesia: Opportunities and Challenges to Support One Map Policy based on Applied Web-GIS

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Abstract. The law number 4 : 2011 and Presidential Decree number 9 : 2016 policy in Indonesia regulates the management of standardization and unification of geospatial data called One Map Policy to achieved one geospatial information which is needed across the institution and ministries. Ministry of Energy and Minerals Resources (MEMR) of Republic Indonesia have managed diverse data which are dynamic and periodically changing, completed with their spatial aspect. To manage those datasets to follow the one map policy, Center of Data and Information Technology unit with task is managing data and information technology developed a Web-GIS platform called ESDM One Map Indonesia that can be used for displaying, analyzing, and monitoring energy and mineral resources. ESDM One Map Indonesia is expected to support various stakeholders in their decision and policy making process, especially in the case of territorial issues. The data in this system is stored in PostgreSQL that exist in an enterprise geodatabase which then published as map services in WMS, WFS, or KML format using Enterprise GIS. Overall, this Web-GIS application could help in monitoring the data development and performing spatial analysis which are can be used for supporting the decision maker. ESDM One Map Indonesia is strong efforts -from MEMR of Republic Indonesia in the form of Web-GIS application for supporting the Indonesian One Map Policy which requires- support and data collaboration from another Ministry/Organization. The willingness from MEMR still needs a support especially keep up with the advancement of Web-GIS based application so that the service provided by ESDM One Map Indonesia can be continuously maintained.



Keywords : Web-GIS Application, MEMR of Republic Indonesia, ESDM One Map Indonesia, Decision Support System, One Map Policy

1. Introduction

Nowadays, the need of space-based analysis continually increases, especially in the fields of regional development and planning. The problems of space and land utilization, which trigger conflicts on land-use overlap, accentuate the requirement of spatial data. Act No. 4/2011 on Geospatial Information becomes one of many emphases on the necessity of geospatial information management. Also, the issuance of the Presidential Regulation No. 9/2016 on the Acceleration of One Map Policy affirms the urgency of spatial data provision. A real-time, spatially performed resource inventory can assist leaders in recognizing changes, trends, and developments in an area as well as provide a complete, accurate, valid, reliable, and up-to-date data for decision making. Regulations on the management of geospatial data standardization and integration, as elaborated in the Acceleration of One Map Policy, are expected to accommodate every existing geospatial information and similar data required by institutions and ministries.

From the perspectives of standard and quality, the existing data is still in need of updates and widely accepted standards to avoid spatial inaccuracy when converted to the standardized data. Moreover, many sectors in ministries or institutions are divided further into several subsectors, resulting in different data formats. The study on One Map Policy, conducted by Hasyim et al. from the Geospatial Information Agency [11], revealed a considerable number of incomplete spatial planning legislations in Indonesia, as listed in **Table 1**. This finding implies that the arrangement of spatial data has not been fully resolved. **Table 2** shows that the geospatial information and topographic maps used as reference in the maps of Basic Geospatial Information are also incomplete. The topographic maps scale 1:250,000 have been finished and available since 2013. In 2014, the topographic maps scale 1:50,000 were available for 72% of the existing national territory, and the topographic maps scale 1:25,000 were limited to Java, Bali, Nusa Tenggara, and Sulawesi. Meanwhile, the provision of topographic maps in the other areas is afoot.

Table 1. Status of the spatial planning legislation at provincial district and city

(Source: www.penataan.ruang.net (update May 26,2015) in Hasyim,2016 [11])

Status	Province	District	City
Not Finished	9	70	9
Already Finished	25	329	84
Formasi Total	34	399	93
Percentage of completion	73.5%	82.5%	90.3%

Table 2. Availability of topographic maps

(Source: Center for topographic mapping and toponymy, Geospatial Information Agency (BIG) in Hasyim,2016 [11])

Scale	Number of Sheet			Percentage
	National Coverage	Already available	Not yet available	
1:5.000	379.012	539	378.473	0.14%
1:10.000	91.547	1074	90.473	1.17%
1:25.000	13.020	3894	9126	29.91%
1:50.000	3899	2837	1.062	72.76%
1:250.000	309	309	0	100%

Puyam S. Singh [18] found a growing need of web-based GIS for easy and fast information sharing and dissemination, which can significantly assist in the decision-making process related to natural resource-based analysis. The rapid development of GIS in the previous decades is an interesting phenomenon, but it also is a new challenge for large-data management and processing [20].

The Center for Data and Information Technology, under the Indonesian Ministry of Energy and Mineral Resource, is responsible- for 18 out of the whole 85 thematic maps in the Acceleration of One Map Policy. The diversity of the data scattered in each unit is a challenge for this center in providing complete, accurate, and latest data. As a network node of spatial data, this institution is developing an Enterprise Geographic Information System, termed as ESDM One Map Indonesia (Energy and Mineral Resource-One Map Indonesia). This system is designed to integrate all data in the sector of energy and mineral resource and to collaborate data management with different parties. ESDM One Map Indonesia displays both reference and thematic maps that come directly from relevant ministries or institutions. Also, it can demonstrate, analyze, and monitor energy and mineral resources that are temporally dynamic and spatially diverse.

A.A. Alesheikh [2] explains that the distribution of geospatial information on the internet allows different layers of society to access it and provides them with media for processing it without location restrictions. Web-based GIS evolves from a variety of web maps and client-server architecture into a wide distribution. Therefore, the internet reshapes every role of an information system, including the functions to collect, store, retrieve, analyze, and visualize data. The high costs of GIS, a specific database system, and system-improving software development fade after the introduction of web-based GIS. The dissemination of spatial information through the internet improves the decision-making process. Both web development and internet expansion have greatly assisted geoscientists in their works, as well as society in general [2], because, first, the web allows for visual interaction with data. Due to the development of web server, clients can now produce maps conveniently. Moreover, since maps and graphics are available on the internet, they can observe any updates directly and hence, fasten the evaluation process. Second, the internet is ubiquitous so that geospatial data can be widely accessed. Consequently, clients can access and acquire necessary data quickly; which enables them to work from almost any locations.

The application of ESDM One Map Indonesia, developed by the Center for Data and Information Technology, is in line with the One Map Policy, i.e., one geospatial reference, one standard, one database, and one geoportal. Furthermore, it conforms with the Economic Policy Package Vol. 8 that elaborates the President's *Nawacita* Program (literally the nine hopes, agendas, or expectations) on the One Map Policy. This policy is actualized in the Presidential Regulation No. 9/2016 as an effort to facilitate the Acceleration of One Map Policy (scale 1:50,000) [6]. Moreover, it gains the support of the Corruption Eradication Commission during the data collection from all ministries or institutions through the coordination and supervision activities.

This WebGIS application develops along with its advantages and disadvantages [2]. The ESDM One Map Indonesia was developed in 2015 with a standard ArcGIS license [9] that allows for simple analyses but not for the complex ones. It also has a speed problem. Because GIS associates with a variety of graphical data, a slow internet connection impedes the appearance of the map service. Alesheik et al. [2] found this condition non-equivalent to the complexity of a specific GIS program like ArcView and ArcInfo or MapInfo in the future. Furthermore, various bugs often appear and potentially disrupt the development of this program. Another problem may emerge from the outdated technology of the application. It is developed using Flex, whereas the technology of WebGIS application is based on Javascript [19]. Emphasizing on the necessity of this application system, the Center for Data and Information Technology develops a better ESDM One Map Indonesia with an updated system. On May 31, 2017, the ESDM One Map Indonesia was finally launched with an updated WebGIS system. This day has, therefore, become a new momentum for GIS development in Indonesia. Qualified infrastructure and architecture are expected to support ESDM One Map Indonesia. The nowadays ESDM One Map Indonesia has already been integrated not only with the

internal sector of the Indonesian Ministry of Energy and Mineral Resources (MEMR) but also with different ministries and institutions. Maps with various themes can help users to identify the potentials and conditions of energy resources.

This research explores ESDM One Map Indonesia from the making step until the development, as well as its opportunities and challenges. In the future, if MEMR wants to optimize the data and the application in ESDM One Map Indonesia, then it will require a full support for up-to-date technology and permanent development. Consequently, ESDM One Map Indonesia is not only the name of an application but also a mature concept of data and information management, especially for spatial data, which is actualized in the form of WebGIS application that can function as a Decision Support System (DSS). The commitment to continuously develop the capacity, capability, and content of the ESDM One Map Indonesia to assist stakeholders in the decision-making process is inevitable. This application is expected to be a reliable source of information and the basis of decision and policy-making processes to support the One Map Policy in national level.

2. Research Area

The coverage of the mapped area on each data contained in One Area Indonesia's EMR is the entire territory of Indonesia, as presented in **Figure 1** below. Some maps that have coverage of almost all areas of Indonesia, namely Map of Oil and Gas Working Areas, Mining Business License, Geological Map, Water Basin Map, Solar Energy Potential Map, and several other maps, while maps that have not covered all regions of Indonesia such as maps, geological disaster maps that are only located in certain locations.



Figure 1. The Area Coverage of ESDM One Map Indonesia
Source: Portal ESDM One Map Indonesia, geoportal.esdm.go.id, 31 May 2017

3. Materials and Methods

3.1. Data

Fuad Hasyim [11], in his paper 'One Map Policy (OMP) Implementation Strategy to Accelerate Mapping of Regional Spatial Planning (RTRW) in Indonesia', explains that the demand on geospatial information in the preparation stage of spatial planning can be divided into two major groups. The first group is Basic Geospatial Information (*Informasi Geospasial Dasar-IGD*) in the form of Indonesian Topographic Map (*Rupa Bumi Indonesia-RBI*). The second group is Thematic Geospatial Information (*Informasi Geospasial Tematik-TGT*) that covers thematic network and basic infrastructure. However,

the local governments have to face particular obstacles in mapping the spatial plans, namely the availability of geospatial information, guidelines, and cross-border human resource and technology.

The data contained in ESDM One Map Indonesia is collected from various sectors in MEMR and other ministries or institutions. All of these data are arranged and stored in the form of geodatabase. This database requires the same coordinate system. Therefore, different sets of data need coordinate system change or transformation [15]. These data are stored in one database according to their themes. Each theme is saved in one map package (.mxd) before being published. The status of the data in ESDM One Map Indonesia is currently divided into two, namely the data coming from the internal sectors of MEMR (presented in **Tables 3-7**) and those from the collaboration of different ministries and institutions (listed in **Table 8**).

The Ministry of Energy and Mineral Resources is a part of JIGN (The National Geospatial Information Network) and is also a member of the One Map Acceleration Policy activity (PKSP). Both are also in line with ESDM One Map Indonesia so that the Map on the ESDM One Map is similar to the one in the acceleration activity of one map. It's just that not all the maps in the ESDM One Map is in the list of map fulfillment on the activity of one policy Acceleration Map in other words the map in ESDM One Map is more varied. In this PKSP Activity, the ESDM Ministry is obliged to fulfill 17 Thematic Maps of the existing themes and the Map in EMR One Map Indonesia is used for the internal needs of the ESDM ministry while for PKSP activities for public interest with certain standards.

Table 3. List of the Maps Acquired from the Oil and Gas Sector in ESDM One Map Indonesia (Source: Portal ESDM One Map Indonesia, geoportal@esdm.go.id, 31 May 2017)

No	Maps	No	Maps
1	Pipelines	20	Oil Import Lane
2	Custody Transfer Points	21	Oil Distribution Lane
3	Platforms	22	Secondary Oil Distribution Lane
4	Lifting	23	Gas Transmission Network
5	HNK Gas and Oil Working Area	24	Gas Transmission Network Towers
6	Conventional Oil and Gas Working Area	25	Gas Distribution Network
7	Current Oil and Gas Working Area	26	Gas Distribution Network Towers
8	Wells	27	Existing LNG Processing Plants
9	Premium Oil and Solar Agents (APMS)	28	Existing LPG Processing Plants
10	Aircraft Filling Depots (DPPU)	29	Existing Upstream Pipes in 2015
11	Gas Filling Stations (SPBG)	30	Existing Open Access Pipes in 2015
12	Subsidized Vehicle Fuel Stations (SPBKB)	31	Existing Distribution Pipes in 2015
13	Diesel Filling Stations (SPDN) – Fueling Stations (SPBN) for Fishers	32	On-going Infrastructures of Open Access Pipes in 2015
14	LPG Bulk Filling and Transport Stations (SPPBE)	33	Areas Reached by Gas Networks
15	Public Filling Stations (SPBU)	34	Oil and Gas Production in 2015
16	Oil Terminals	35	Oil and Gas Production in 2016
17	Gas Processing Plants (Refinery)	36	Wells
18	Oil Processing Plants (Refinery)	37	SEISMIC_2D
19	Gas Supply Lines	38	SEISMIC_3D

Data format is also incredibly significant while using web-based GIS system. The formats are vector and raster; both of which have advantages and disadvantages [2]. A raster data, such as satellite image, depicts an object according to reality. Even though it is highly visible and identifiable, it is, however, lack of cartographic aspects. Moreover, identifying a single object is improbable because raster data is composed of pixels. A contact to the server is required per request by the clients when loading a large

raster data, for instance, during data zooming. This type of data also has a limited appearance in different zoom levels. The dimension of raster data recording changes when users try to obtain more details from it. The data appears in blurs and becomes less informative, prompting the need to provide multiscale raster data with different accuracy or to deliver good quality image in various scale range.

Table 4. List of the Maps Acquired from the Mineral and Coal Sector in ESDM One Map Indonesia (Source: Portal ESDM One Map Indonesia, geoportal@esdm.go.id, 31 May 2017)

No	Maps
1	Mining Business License Area (WIUP) for Metal Mineral
2	Mining Business License Area (WIUP) for Non-metal Mineral and Stone
3	Mining Business License Area (WIUP) for Coal
4	Smelters
5	Coal Terminals
6	Mining Areas
7	Coal Formations
8	Mineral Formations

Table 5. List of the Maps Acquired from the Electricity Sector (Source: Portal ESDM One Map Indonesia, geoportal@esdm.go.id, 31 May 2017)

No	Maps	No	Maps
1	Geothermal Power Plants (PLTP)	11	Electricity Infrastructure in Bangka
2	Micro Hydropower Plants (PLTM/PLTMH) <10MW	12	Electricity Infrastructure in Belitung
3	Solar Power Plants (PLTS) <10MW	13	Electricity Infrastructure in Java Island
4	Off-grid Generators (national budget)	14	Electricity Infrastructure in Kalimantan Island
5	Bioenergy-based Generators	15	Electricity Infrastructure in Sumatra Island
6	Substations	16	The Project Locations in 2,500 Villages
7	Distribution Substations	17	Electrification Ration in 2014-2016 per Regency
8	Transmission Network	18	Electrification Ration in 2014-2016 per Province
9	Distribution Network	19	Recapitulation of Installed Capacity
10	Distribution Line Network	20	35.000MW Electricity Generator Program

Table 6. List of the Maps Acquired from the New Renewable Energy and Energy Conservation Sector (Source: Portal ESDM One Map Indonesia, geoportal@esdm.go.id, 31 May 2017)

No	Maps	No	Maps
1	Geothermal Potentials	12	The Blending Facilities of PT. AKR
2	Oil Palm Potentials	13	The Blending Facilities of PT. Pertamina
3	Potentials of Waste Power Plants (PLTSA)	14	Biodiesel
4	Micro Hydro Potentials	15	Bioethanol
5	Sea Current Potentials	16	Biogas Plant Constructions
6	Sea Current Conversion	17	Distribution of Industries with Energy Consumption > 6000 TOE
7	Distribution of Methane Content	18	Compact Fluorescent Lamp Company with Energy Efficient Label
8	Distribution of Gas Types	19	Existing Geothermal Working Area
9	Distribution of Gas Indications	20	Specified Geothermal Working Area

No	Maps	No	Maps
10	Wind Energy Potentials	21	Assignment Area for Preliminary Survey
11	Solar Potentials		

Vector data has a lighter load and, therefore, it transmits faster than raster. Users can do more spatial analysis on vector data rather than on raster, which requires initial extraction. In different zoom levels, the dimension of the object in vector data remains. Furthermore, a single, specific object is identifiable with an excellent detail. Vector data does not need a contact to the server in every execution in the browser because it has a light data load. However, the disadvantage of vector data includes a rigid appearance, which is unlike the real world. This data largely depends on the processing and the making of the data itself, the accuracy of data processing, and the adequacy of the existing information. Moreover, the distribution of vector data may also compromise copyright rules. The choice of data format (either vector or raster) varies according to the existing application and infrastructure [2].

Table 7. List of the Maps Acquired from the Geology Sector in ESDM One Map Indonesia (Source: Portal ESDM One Map Indonesia, geoportal@esdm.go.id, 31 May 2017)

No	Maps	No	Maps
1	Geology	11	Non-metal Mineral and Stone Potentials
2	Hydrogeology	12	Potentials of Seabed Surface Sediment Distribution
3	Sediment Basin	13	Potentials of Marine Minerals
4	Groundwater Basin	14	Groundwater Drilling (2003-2014)
5	Karst Landscape Area	15	Distribution of Gravity Core Data in the Sea
6	Coal Potentials (2016)	16	Volcanic Disaster-prone Areas
7	Solid Bitumen Potentials	17	Earthquake-prone Areas
8	Coal Bed Methane (CBM) Potentials	18	Tsunami-prone Areas
9	Peat Potentials (2011)	19	Mass Wasting Susceptibility Zones
10	Metal Mineral Potentials (2015)		

Table 8. List of the Maps Acquired from Other Ministries and Institutions in ESDM One Map Indonesia (Source: Portal ESDM One Map Indonesia, geoportal@esdm.go.id, 31 May 2017)

No	Maps	No	Maps
1	Provincial Administration Boundaries	11	Navigation Points
2	Administrative Boundaries of Regencies	12	Crossing Points
3	Administrative Boundaries of Districts	13	Seaports
4	Protected Forest Area	14	Railway Stations
5	Conservation Forest Area	15	Sea Lanes
6	Production Forest Area	16	Railway
7	Limited Production Forest Area	17	Master Plan for the Development of National Industries
8	Convertible Production Forest Area		
9	Special Purpose Terminals		
10	Private Interest Terminals		

3.2. Methods

3.2.1 The Development of ESDM One Map Indonesia The data in ESDM One Map Indonesia is stored in an enterprise geodatabase using the DBMS (Database Management System) PostgreSQL and, then, published as a map service in the format WMS, WFS, or KML. This WebGIS application is developed using Javascript and HTML5. It is also called as a dynamic web browser [1]. A dynamic map allows

users to select any features displayed on it, such as scale and location [1]. In this type of application, the map is depicted according to predefined parameters and, then, the web browser displays it as a picture. Users can change these parameters and thereby, observe and produce a new map. However, since this application contains geographic data, GIS software, and an interface program, it causes a heavy load on the server. It also requires a program to provide a map service. GIS-based planning support system enables planners and citizens to create and test scenarios of development alternatives quickly and efficiently as well as determine the potential impact of a particular land use pattern along with the population and employment trends in the future. Therefore, it assists public officials to make an informed decision for future planning. Furthermore, most urban, community, and regional planning strategies are complicated, which then require the involvements of local, provincial, and national governments [10].

A.A. Alesheikh explains that the main purpose of the development stage of WebGIS is to determine 'how' WebGIS performs the applications required in database planning, depicts an object into graphics (e.g., color, size, and symbol), creates the structures of graphic files and non-graphic attribute files, activates the layers, chooses the scale on which the map layer is opened, and displays the GIS products. Also, the management and security restrictions during data access by users are determined at this stage. This development can be performed by selecting the sources (e.g., documents, maps, and digital files), preparing the actual database designs (logical/physical design), determining the procedures for data conversion from source media to the compatible database, and defining the procedures for database management and maintenance [2]. The structure of the spatial database is designed to accommodate (i.e., to save, manage, and access) various types of data, including basic geographic data, field observation data, and remote sensing information. ESDM One Map Indonesia is an integrated spatial data management system built using ArcGIS technology. ArcGIS provides software for spatial data processing (ArcGIS for Desktop), data storage system (Geodatabase), software for spatial data sharing (ArcGIS for Server), and a multi-purpose spatial data platform (Portal for ArcGIS) for data utilization. Geoserver is used to generate and publish web-based map service and web feature service, keyhole markup language, and all of the things necessary to the development of WebGIS application [7] [19].

3.2.2 The Management of ESDM One Map Indonesia

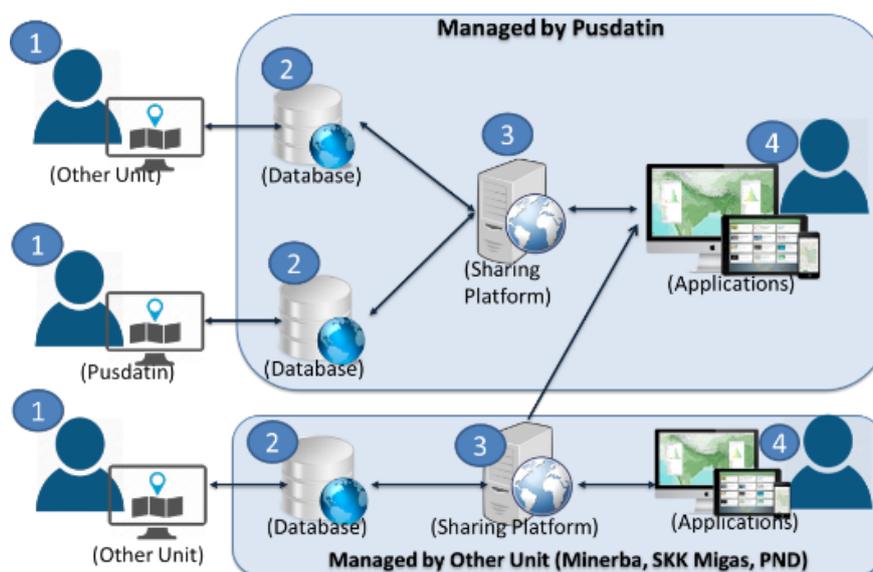


Figure 2. The Management of ESDM One Map Indonesia
Source: Center for Data and Information Technology MEMR, 2017

The management process of ESDM One Map Indonesia is performed in two ways. First, the units (i.e., Directorate-Generals and Agencies) that have the same GIS application and infrastructure can integrate their maps through a map service in ESDM One Map Indonesia directly. Relying on this system, the Center for Data and Information Technology can obtain the latest updates from the units without the complexity of data processing. Second, the units that have no GIS application and infrastructure receive supporting facilities to collaborate with other units in data management in the ESDM One Map Indonesia. In this way, the data can be managed by the respective Directorate-Generals and Agencies. **Figure 2** illustrates the data integration flows in ESDM One Map Indonesia, which include:

1. The Persons in Charge (PICs) of the data in each unit manages their data by themselves, while the Center for Data and Information Technology manages the cross-sector data and monitors the data from the other units.
2. The data is saved in a Geodatabase Server that is managed by the Center for Data and Information Technology or every unit.
3. The data is published using ArcGIS Server that is organized by the Center for Data and Information Technology.
4. The data is displayed in various applications and shared with relevant parties.

3.2.3 The Future Management of ESDM One Map Indonesia. Surya Herjuna et al., in a scientific article titled *Pemanfaatan Aplikasi SIG Berbasis Web Untuk Penataan Sektor Pertambangan Indonesia (The Utilization of Web-based GIS Application for Structuring the Mining Sector in Indonesia)* [23], stressed on the constant development of web-based GIS application, which aims to optimize monitoring process and synergize cross-institution data (between different ministries and institutions). The process of data synergy involves ministries and other institutions to be able to obtain a view of the systems and the processes used in web-based GIS system. Surya Herjuna et al. also divided the development of web-based GIS application into short, mid, and long-term. Each term consists of several strategic plans, for instance, to develop the following hardware, software, database, and brainware [23]:

- a. Hardware development includes the provision of server, computer, firewall system, internet network, and others.
- b. Software development on map application, attribute data input technique, and tools for data analysis.
- c. Database development includes the cooperation of ministries or other institutions in data exchange to strengthen national database, the reconciliation of license data in the regions, and the input of attribute data in every company.
- d. Brainware development consists of training for central administrators and local governments.

In the future, ESDM One Map Indonesia will be developed further by optimizing the role of every management position presented in **Figure 3**.

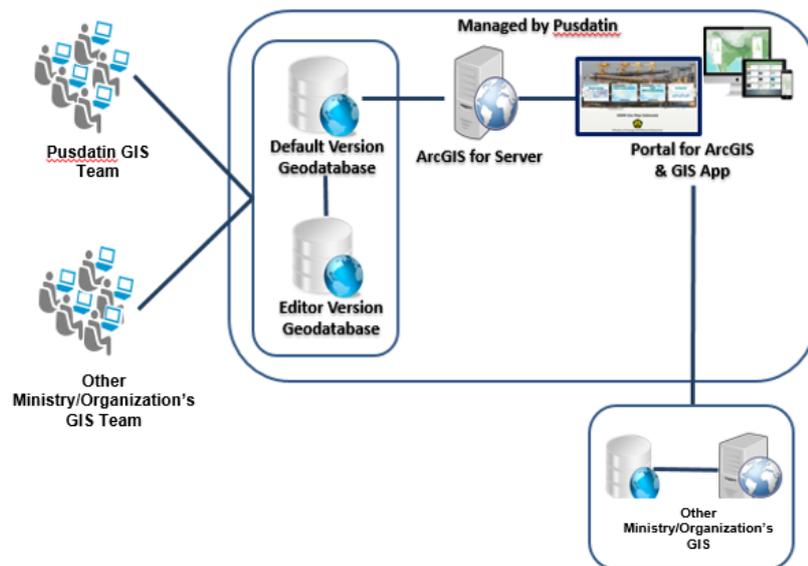


Figure 3. The Future Management of ESDM One Map Indonesia
Source: Center for Data and Information Technology MEMR, 2017

4. Result, Analysis, and Discussion

4.1 One Map Policy

According to the Act No.4/2011 on Geospatial Information Article 2 [5], geospatial information has to be organized by legal certainty, integrity, openness, sophistication, accuracy, usefulness, and democracy. Article 3 explains the objectives of this act, namely (b) to actualize an effective and fruitful implementation of geospatial information through a cooperation in coordination, integration, and synchronization; and (c) to encourage the use of geospatial information in governance and various aspects of the society's life. The Coordinating Minister for Economic Affairs who read out the Economic Policy Package Vol. 8 states that the development of an area or an infrastructure often collides with some problems related to space and land utilization. This conflict is very difficult to resolve because the Thematic Geospatial Information overlaps to each other. Therefore, the One Map Policy, referring to one geospatial reference, one standard, one database, and one geoportal, is expected to accelerate the implementation of national development, which is one of the government's priorities. The same basis for map reference will also increase the reliability of information on the locations of various economic activities for business certainty. The diverse information compiled in this one map can also be used to design various simulations, e.g., disaster mitigation. Following the Presidential Regulation on the Acceleration of the Implementation of One Map Policy [6], ministries and institutions will prepare thematic maps scale 1:50,000 before the deadline, i.e., in the year 2019, according to their respective action plans.

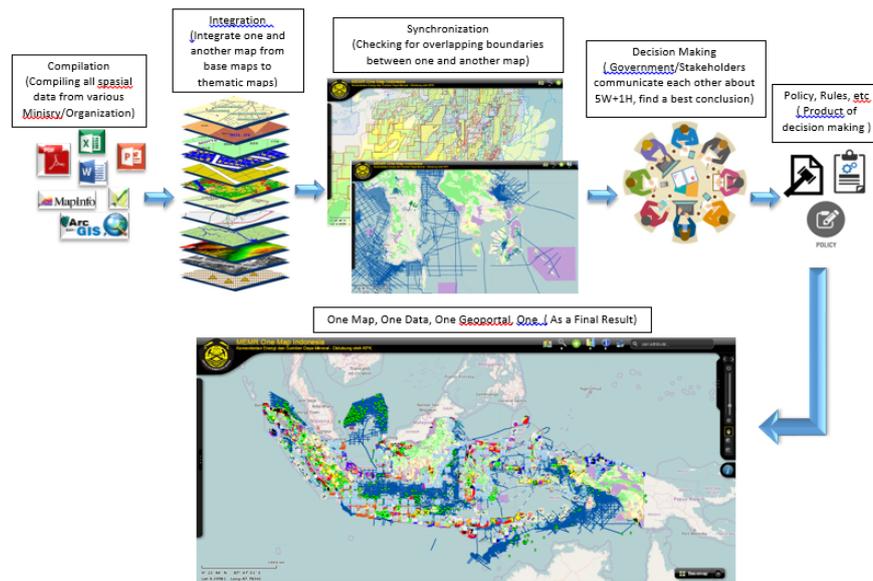


Figure 4. The Illustration of One Map Policy in ESDM One Map Indonesia
Source: Center for Data and Information Technology MEMR, 2017

The Acceleration of One Map Policy is expected to become a reference for spatial data improvement, spatial planning accuracy, and the accuracy of policy formulation and decision making through the following steps: the compilation, integration, and synchronization of 85 thematic maps from 19 ministries/institutions in 34 provinces in Indonesia. **Figure 4** illustrates the One Map Policy in ESDM One Map Indonesia as a collaboration between GIS and web, which also employs compilation, integration, and synchronization steps in producing a widely accessible portal. A.A. Mustaffa [4] reveals that the compilation of GIS techniques is widely used in many sectors, especially those that require a lot of data management. The concept of One Map Policy using web-based GIS is in line with Yu P. Yuronen [25], which explains that the data in GIS supports the current information technology and informatics and provides an opportunity to evaluate the status of the natural environment in many regions in real time. There are various definitions and objectives of web-based GIS [4]. According to the field study of this research, it is defined as a database system on a computer designed to support data or information acquisition, storage, analysis, and presentation in a selected location. Through GIS the required information can be accessed quickly and accurately. Another advantage is that GIS offers the ability to connect spatial data with attribute data so that the GIS data becomes more useful for analytical purposes. Consequently, web-based GIS can assist leaders to make an informed decision

As mentioned previously, the data contained in ESDM One Map Indonesia is collected from different sectors of MEMR and other ministries or institutions, and then arranged and stored in a geodatabase. The data used in this research are mostly vector, in the forms of point, line, and polygon. The GIS data collected from the above sectors and ministries/institutions have different formats. Therefore, these data have to be transformed into one reference system [1] according to the standard of the One Map Policy (**Tables 9-11**) before they are combined into a single entity. The datum also conforms to the same standard, i.e., datum WGS 84 with GCS projection. The standard for the data format adopted in the Acceleration of One Map Policy is as follows.

Table 9. The Parameter of Geospatial Information Standard for One Map Policy

Source: *Modul Integrasi Informasi Geospasial Tematik* (Module of Integrated Thematic Geospatial Information), The Acceleration of One Map Policy Secretariate, 2016

Information Type	Units	Description
Geospatial Thematic Information's Name	-	Name of Geospatial Thematic Information
Data Format	Shape file (.shp) and Geo database (.gdb)	Type of data which is used in data making
Coordinate System	Geographic	Coordinate system that used is Geographic Coordinate System
Datum	WGS (World Geographic System) 1984	The datum information based on WGS 1984
Map Scale	1:10.000 up to 1:1.000.000	The scale for making Geospatial Thematic Information

Table 10. Geospatial Information Quality Parameter (position accuracy) for One Map Policy

Source: *Modul Integrasi Informasi Geospasial Tematik* (Module of Integrated Thematic Geospatial Information), The Acceleration of One Map Policy Secretariate, 2016

Types of Information	Units	Descriptions
Position Accuracy		
The conformity of IGT* elements with the shoreline in IGD*	Yes/No/Incomparable	The conformity of object depiction in IGT with shoreline in IGD
The conformity of IGT elements with the regional boundaries in IGD	Yes/No/Incomparable	The conformity of object depiction in IGT with regional boundaries in IGD
The conformity of the geometric elements of IGT with the other IGD elements and/or satellite images	Yes/No/Incomparable	The conformity of object depiction in IGT with shoreline in IGD

Notes: *IGT= Thematic Geospatial Information; IGD= Basic Geospatial Information

Table 11. Geospatial Information Quality Parameter (consistency) for One Map Policy

Source: *Modul Integrasi Informasi Geospasial Tematik* (Module of Integrated Thematic Geospatial Information), The Acceleration of One Map Policy Secretariate, 2016

Types of Information	Descriptions
Consistency	Improvement activity process includes primary field, attribute consistency, and consistency
Database	Improvements based on the standards of IGT mapping
a. Primary field	The improvements of several main pieces of information (fields) contained in the database
b. Attribute Consistency	The improvements of geospatial attribute
c. Standard Consistency	
c.1 Classification-based standard consistency	Improvements based on the standards of IGT mapping
c.2. Standard consistency according to geodatabase	

Types of Information	Descriptions
Topology	The improvements refer to 1) a point inside a polygon and 2) no duplication at the same location
a. Point	
b. Line	The improvements refer to 1) no overshoot and undershoot lines, 2) no intersection between different lines, and 3) no stacking lines
c. Area	The improvements refer to 1) no overlapping areas and 2) no abutting empty areas

4.2. GIS dan Web-GIS

Geographic Information System (GIS) is a tool used to acquire, manage, analyze, and present every information related to space or spatial properties. GIS is capable of displaying various complicated data on a map and presenting an easily readable, accessible, and understandable information [1]. GIS grows along with the integration of web system and the internet and hence, it can synchronize spatial information in real time. With the internet, the distribution process of a considerable number of data becomes more efficient compared to manual dissemination.

In the development, GIS and WebGIS-based analyses are increasingly adopted for a variety of purposes, such as environment and resource analysis [11], [15], [18], [21], [26]; rainfall distribution analysis [3], mining analysis [16], [19]; monitoring activities [7], [22], [25]; disaster analysis [1], [4], [17], [28]; and urban planning [12], [13], [14], [27]. Stancovic et al. [19] demonstrated the benefits of WebGIS system for the management of abandoned mining sites in Serbia. In line with this study is Herjuna et al. [23] that employed WebGIS to structurize the mining sector in Indonesia.

Aye et al. [28] studied the utilizations of a collaborative WebGIS to manage the risks of hydrometeorological hazards in different countries in Europe as well as a WebGIS-based spatial application like jecami.eu (developed in Switzerland) to monitor the ecological conditions of the Alpine [11]. These two studies are examples of the developments of GIS and WebGIS utilizations in urban and resource planning. All of them used data that were obtained from relevant authorities. In other words, the data used in their studies meet the specific standards and quality or, in other words, they are accountable. Consequently, web-based GIS application becomes significant in supporting the actualization of One Map Policy.

Nowadays, many research and development projects apply web services to the GIS systems in various companies and institutions [27]. The ability to store and process the necessary data that refer to an area or space induces this system's wide utilization as a tool for solving the problems in management and planning. The mapping method employed by this system gives users a considerable amount of information visually, which can function as a reference in the predictions of many objects and events [21]. GIS is a suitable tool for planners to analyze their target areas.

WebGIS application improves the efficiency of information dissemination to stakeholders, particularly decision makers. Siti Maneesa Amiruddin [22] studied the web-based GIS application like ESDM One Map Indonesia and its functions in assisting staffs to organize and analyze relevant data and to publish information in the forms of maps, diagrams, and reports. The benefits of applying a real-time WebGIS to resource monitoring [22] include the reduction of monitoring cost, the acceleration of decision-making process (due to the ability to make decisions based on real-time information), and the extensive accessibility (everyone can access it via the ubiquitous internet).

GIS allows its users to conduct a more detailed spatial analysis in a region [16]. There have been various benefits of a collaborative GIS in ESDM One Map Indonesia.

- a. Every working unit responsible for data management can erase the conflicts that emerge due to different versions of the data used as a map reference.
- b. It is effective and time- and resource-efficient.

- c. It guaranteed that the accessed data is the latest (up-to-date) version
- d. The availability of a complete, accurate, and up-to-date data provides an opportunity for stakeholders to increase their investment and production of energy and mineral commodities.

GIS is a computer system used to capture, store, check, and display data related to positions on the Earth's surface [3]. It can show various types of data on one map, which then allows people to observe, analyze, and understand patterns and relationships more easily. With GIS technology, people can compare the locations of many objects and events to find how they relate to each other [12]. Overall, GIS is a suitable tool for organizing information and involving the following operations, i.e., data planning, observation, collection, storing, management, analysis, to produce usable information in the decision-making process [3]. Web-based GIS enables people, even those with no technical GIS background, to use it as a decision-making tool and to observe as well as modify real-time information [8] for analysis of energy and mineral resource potentials [17].

4.3. ESDM One Map Indonesia

ESDM One Map Indonesia is a web-based information system capable of displaying various thematic geospatial information (maps) in the field of energy and mineral resource online (webGIS). As illustrated in **Figure 5**, the Minister of EMR, Ignasius Jonan, officially launched ESDM One Map Indonesia on May 31, 2017. This application presents a variety of thematic geospatial information obtained from different sectors of MEMR, namely Oil and Gas, Mineral and Coal, New Renewable Energy and Energy Conservation, Electricity, Geology, and Research Development Sectors. The information includes, for instance, the maps of Oil and Gas Working Area, Mining Business License Area, Geothermal Working Area, Electricity Infrastructure, Oil and Gas Infrastructure, and Potentials (Resources and Reserves) of New Renewable Energy and Geology. This system also provides thematic geospatial information from other sectors in different ministries or institutions.



Figure 5. The Launching of ESDM One Map Indonesia on May 31, 2017. The Minister of EMR gave a direction during the launching event (a), the Head of the Center for Data and Information Technology assisted the Minister and Secretary General of EMR to try the application of ESDM One Map Indonesia (b), the Minister of EMR signed the map in ESDM One Map Indonesia (c), and committees assisted the guests to try the analytical features in ESDM One Map Indonesia. Source: Center for Data and Information Technology MEMR, 2017

The initial purpose of ESDM One Map Indonesia was to create a regionally-arranged data inventory in MEMR. However, this application develops into a platform for the decision makers in MEMR to plan EMR infrastructures and analyze mining licenses and existing EMR potentials.

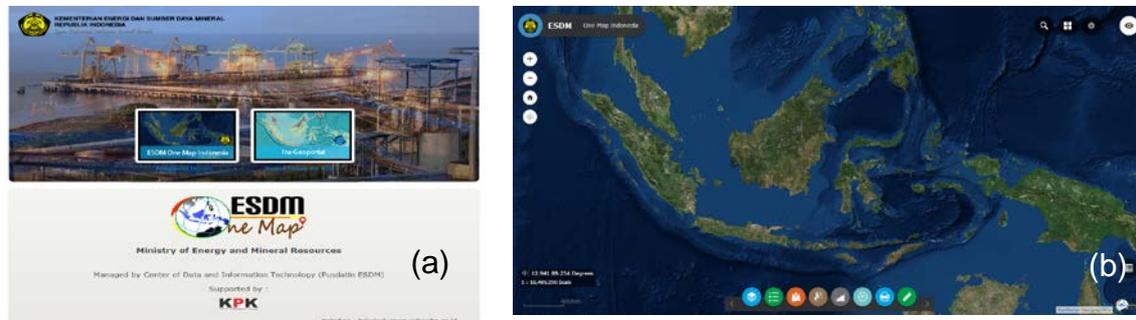


Figure 6. (a) The Home Page and (b) After Log-In Window in the Portal
Source: Portal ESDM One Map Indonesia Indonesia, geoportal@esdm.go.id, 2017

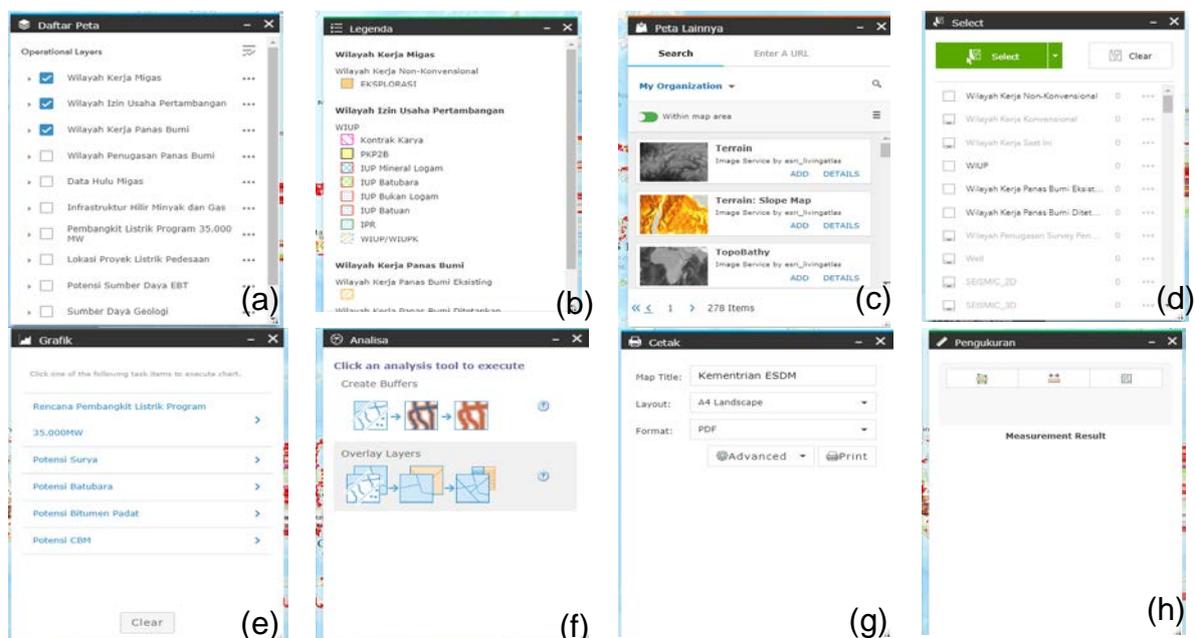


Figure 7. Various Menus in ESDM One Map Indonesia, i.e., (a) Map List, (b) Legends, (c) Search for Other Maps, (d) Selecting and Statistic Tools, (e) Graphics, (f) Analysis Tools, (g) Print, and (h) Measurement Source: Portal ESDM One Map Indonesia Indonesia, geoportal@esdm.go.id, 2017

Figure 6 shows the home page and after log-in window in the Portal of ESDM One Map Indonesia, while **Figure 7** shows the menu panel in the portal. The top right side in the after log-in page offers several options for ArcGis basemap or Openstreet Map, viz. topographic map, road network map, and satellite image, that facilitate various perspectives and interests in some analyses. The various menus in ESDM One Map Indonesia accommodate the diverse needs of users. The ‘Map List’ shows the default maps in the portal, while the other maps can be searched using ‘Search for Other Maps’. Every map in this list automatically displays the description of the objects on the menu ‘Legend’. For a simple analysis like distance and area, users can use ‘Measurement’. Users can also find a simple statistic of the selected data from ‘Selecting and Statistic Tools’. Moreover, they can display the graphics of various selected maps using the menu ‘Graphics’, further analyze some particular data (e.g., land use overlap) using ‘Analysis Tools’, and print the resultant map from the menu ‘Print’.

Currently, ESDM One Map Indonesia has been integrated with other geographic information systems from some units of MEMR, namely the Special Work Unit of Oil and Gas and the Directorate-General of Mineral and Coal. The Portal of ESDM One Map Indonesia has organized hundreds of data from all units of MEMR, including the Oil and Gas Working Area, Data of Upstream Oil and Gas Activities, Mining Business License Area, Electricity Infrastructure, Geothermal Working Area, Potential of New Renewable Energy and Energy Conservation, and Natural Resource and Geological Disaster. It also displays the data obtained from other ministries. These data are Administrative Boundaries, Transportation Infrastructures, and Forest Areas. This system can be accessed publicly or by using an account (username and password) for data editing purpose and internal use of MEMR units. All data presented in ESDM One Map Indonesia has gone through layers of verification and validation process by either the data management team at the Center of Data and Information Technology or the sources (units or institutions) of related data.

4.4. ESDM One Map Indonesia in One Map Policy

The development of ESDM One Map Indonesia is the manifestation of one objective of the Energy Coordination and Supervision Activities initiated by the Corruption Eradication Commission and MEMR. The objective is to develop an integrated data system as an implementation of One Map Policy in MEMR. The EMR data has a strategic role in decision making. The available spatial data of energy and mineral resource is distributed in different working units in MEMR, business entities, and related stakeholders. Furthermore, the spatial data is dynamic, i.e., changing over time. Also, there is a high demand from the leaders in MEMR and the public on open access to the data and information about energy and mineral resource. The need of easily acquired, complete, and accurate data is the reason why ESDM One Map Indonesia becomes necessary and in line with One Map Policy.

In the National Geospatial Information Network (*Jaringan Informasi Geospasial Nasional* -JIGN), the Center for Data and Information Technology acts as a network node in MEMR. It performs the functions of geospatial information coordination, integration, and dissemination between the Data Representatives (i.e., those responsible for the data) in MEMR and other ministries/institutions. It also acts as a Network Node Connector (Geospatial Information Agency). The role of this center in organizing thematic spatial data about energy and mineral resource is affirmed in the Act of Geospatial Information (Act No. 4/2011) [4] and the National Geospatial Information Network (as a network node). Regarding the integration and dissemination of EMR thematic geospatial information, the existence of ESDM geportal (ESDM One Map Indonesia) is strongly significant in providing the tools that can meet the demand for thematic geospatial information online. ESDM One Map Indonesia, built by the Center for Data and Information Technology, has also met the standard for geportal application specified by the Geospatial Information Agency as the Network Node Connector.

ESDM One Map Indonesia provides a variety of information on EMR potential and infrastructure. Some of which can be used to identify the distribution of filling stations, which support the implementation of one fuel price program, to display the statistical potential of EMR and attract investors to develop EMR infrastructures, to analyze regional zonation, and to analyze land-use overlap in spatial planning, as presented in **Figure 8**.

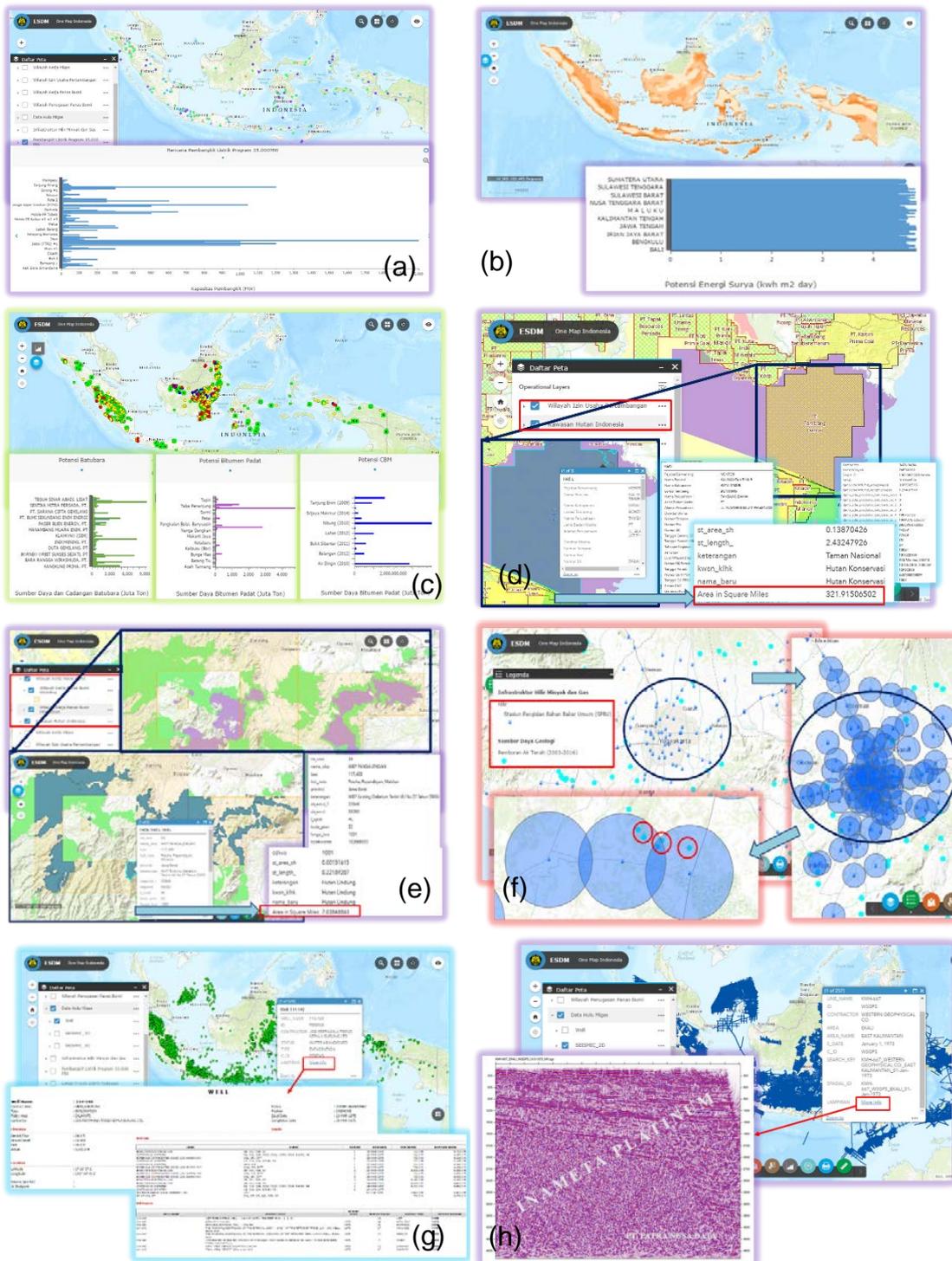


Figure 8. (a) Analyses of the Potent Resource of Power Generator, (b) Solar Energy Potential, (c) Geological Resource Potential, (d) Land Use Overlap between Mining Areas and Conservation Forest Areas, (e) Land Use Overlap between Geothermal Working Area and Protected Forest, (f) Buffer Distance between Filling Stations and Groundwater Drilling Sites, (g) Integration of Non-spatial Data (Detailed Data of Wells) and Well Distribution, (h) Integration of Non-spatial Data (Detailed Seismic Data) and Well Distribution
Source: Center for Data and Information Technology MEMR, 2017

ESDM One Map Indonesia is expected to provide solutions for a collaborative Geographic Information System, namely:

1. Eliminating any problems emerging due to different versions of the data used as a reference and giving a guarantee that the accessed data are the latest (up-to-date) version.
2. Increasing the effectiveness and efficiency of time and resources in data management and dissemination. Working units are responsible for their own data.
3. Supporting the leaders in the decision-making process and providing a vast opportunity for stakeholders to increase their investments and productions of EMR commodities.

The benefits of ESDM One Map Indonesia in One Map Policy are as follows:

- a. To facilitate the preparation of large-scale space utilization planning using an integrated spatial plan document.
- b. To facilitate and accelerate the settlement of land use conflicts, including the ones in customary lands.
- c. To accelerate the implementation of the development programs, including the development of areas and infrastructures.
- d. To facilitate and accelerate the completion of the regional boundaries in Indonesia.
- e. To facilitate and accelerate the issuance of land use-related permits.
- f. To facilitate the implementation of any simulations that require maps, such as disaster mitigation, environmental preservation, and defense.
- g. To improve the reliability of information related to various economic activities, which will provide a much-needed business assurance at this time.

Apart from the many benefits mentioned above, some critical notes on ESDM One Map Indonesia must be considered in the future, such as:

- a. The data owners, who have submitted their data to the Center for Data and Information Technology, are less responsive and participative in monitoring the results on ESDM One Map Indonesia, especially regarding the precision of object location (e.g., the inland generators that are still located in the sea or the locations of any companies that shift after data conversion).
- b. The data format used by the units responsible for the same resources is different. The unification of the data attribute tends to take much time (e.g., the electricity data has different formats for resource inventory). The variety of data formats affects the data attribute in ESDM One Map Indonesia)
- c. The differences in the application or platform used in the units (internal sector of MEMR) and other ministries/institutions. The diversity complicates the integration process. Until recently the data that can be integrated directly with the map service are those coming from Elnusa (PND), Special Work Unit of Oil and Gas (SKK Migas), Mineral and Coal Sector, and some other ministries or institutions like Geospatial Information Agency (which provides the data of administrative boundaries). However, since the application of ESDM One Map Indonesia relies strongly on internet connection, a network interference on data sender's location causes the map service to not appear.

ESDM One Map Indonesia enables accessibility and a collaborative interaction between different stakeholders [28]. Regarding legal responsibility, a real collaborative decision making is not always possible and is beyond the capacity of the decision support system. This platform supports a collaborative interaction between different stakeholders to actualize a better and transparent decision-making environment. The frame of this platform adopts a common design so that it is applicable and highly flexible in different regions. The types of users and the levels of involvement and interaction in the platform depend on the institutional setting, role, and responsibility of each user in a particular area.

ESDM One Map Indonesia is a significant effort of MEMR, along with the supports and data collaborations from other ministries or institutions, to actualize the One Map Policy with WebGIS application. The willingness of MEMR still requires many supports especially to advance the Web-

GIS application constantly and to be able to provide services through ESDM One Map Indonesia continuously.

5. Conclusion

ESDM One Map Indonesia can be used for various regional analyses, for instance, the analyses of resource potential, land use overlap, and the integration of non-spatial and spatial data. It can be accessed using computers and mobile phones from anywhere by anyone and at any time as long as internet connection is available. It can also function as a source of information and the basis of policy and decision-making process, all of which promote the actualization of One Map policy on a national level.

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