Preliminary Study of WebGIS Implementation on Monitoring and Evaluation of the Regional Action Plan for Reduction and Elimination of Mercury Use (RAD-PPM)

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ABSTRACT

Presidential Regulation Number 21 of 2019 concerning the National Action Plan for Mercury Reduction and Elimination (RAN-PPM) became the strategy for reduction and elimination of Mercury, then later revealed in the Regional Action Plan for Mercury Reduction and Elimination (RAD-PPM). According to it, a comprehensive monitoring method is urgently needed, neither only related to the elimination of mercury in the ASGM sector, but also for regional development potential. This research is a Research and Development research, which is a type of research that aims to develop applications, which are used as a tool for decision making-a Decision Support System (DSS). Using a descriptive qualitative method, to analyse related documents, interviews with related actors, and calculate System Usability Scale to analyse and see the usability and the level of user acceptance to the WebGIS. The case study is the development and preparation of a WebGIS related to the ASGM sector in Kokap, Kulon Progo. The result of the study shows that an information system with geospatial-based analysis could facilitate data integration, implementation and monitoring of the regulation of mercury elimination, especially in the ASGM sector. As a result of the WebGIS System Usability Scale for Small-Scale Gold Mining in Kulon Progo Regency, it is included in the category of applications that can be accepted by users and is quite appropriate. Nevertheless, synergy and cooperation between various agencies are necessary. Moreover, the data related to socio-economic which is an important information system for regional development can also be mapped in a GIS.

Keywords: *Geographic Information System, supervision, Regional Action Plan for Mercury Reduction and Elimination (RAD-PPM), ASGM, regional development*

INTRODUCTION

Small-scale Gold Mining or ASGM is a mining and processing activity that mostly uses mercury amalgamation to extract gold from ore. This process is the largest source of mercury release worldwide, accounting for 35% of all mercury emissions. In fact, according to the United Nations Environmental Program in 2012, the use of mercury in the ASGM sector reached 1,400 tons/year. However, ASGM is a sector that contributes around 12 to 15% of the world's gold (Kristianingsih, 2018).

Where endeavours to reduce and eliminate mercury in Indonesia have been initiated since 2010. From 2010 to 2013 Indonesia participated in the Intergovernmental Negotiating Committee (INC) 1 to 5 which was the initial preparation for the establishment of the Minamata Convention. Indonesia is also actively involved in the preparation process, then in 2017 the President of the Republic of Indonesia in a limited meeting issued 7 presidential instructions related to the reduction and elimination of mercury: 1) reorganizing the governance of ASGM, 2) halting use of mercury in Indonesia, 3) strict supervision of the use of mercury, 4) supervision of sources of mercury acquirement and conveyance, 5) society understanding of the hazardous of mercury, 6) use of the livelihoods of ASGM miners and 7) medical assistance for the mercury community as a follow-up to the ratification of the Minamata Convention, Indonesia develop the Law Number 11 the Year 2017 concerning Ratification of the

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Minamata Convention Regarding Mercury which was approved by the Indonesian Parliament on September 13, 2017 (Krisnayanti & Probiyantono, 2020).

Then the Presidential Regulation Number 21 of 2019 concerning the National Action Plan for Mercury Reduction and Elimination (RAN-PPM) was issued as a reference for the Mercury reduction and elimination strategy which has a target of reducing 50% in the manufacturing sector, 33.2% in the energy sector in 2030 and 100% in the ASGM sector by 2025. This RAN-PPM was later also revealed in the Regional Action Plan for Mercury Reduction and Elimination (RAD-PPM) which is the obligation of the governor in the process of implementation, monitoring and sustainability as stipulated in Presidential Regulation No. 21 In 2019 article 10 letter a, the procedure for preparing RAD-PPM is in accordance with the concept of Sustainable Development with 3 main principles, scilicet the stage of preparing technical studies, compiling materials and deciding RAD-PPM (Krisnayanti & Probiyantono, 2020).

The implementation of RAD-PPM is also an effort of the Regional and Central governments in implementing sustainable development goals which are part of the paradigm in development (Mensah, 2019) (Rosana, 2018). In practice, sustainable development requires the involvement of all actors and parties across sectors and studies regions and institutions (Gold, 2015). This is also in line with the principles of implementing the Sustainable Development Goals (SDGs), namely Universality, Integration, and No One Left Behind which involves all stakeholders including the community and also academia (Darajati, 2016).

The RAN-PPM and the strategy for its implementation emphasized the development of an information system to support the implementation of the RAN-PPM, especially in terms of monitoring and evaluation. In CHAPTER V Article 19 of the RAN-PPM, stated that there is a need for an information system as an integrated monitoring and evaluation system in efforts to reduce and eliminate mercury. The implementation strategy is explained below:

1. Strengthening commitment, coordination and cooperation between related institutions
2. Strengthening coordination and cooperation between central and regional governments
3. Strengthening community involvement through communication, information and education
4. Establishment of information system
5. Strengthening the commitment of the business community in reducing mercury
6. Application of environmentally friendly alternative technologies
7. Diversion of local people's livelihood
8. Strengthening law enforcement (Krisnayanti & Probiyantono, 2020).

The development of information technology today has increasingly facilitated the dissemination of information more broadly and growing rapidly. Its utilization is currently widely used by various agencies and organizations to facilitate various activities, including in supporting the process of implementing a program or policy. Since the development of information technology, many new discoveries in information technology have emerged. One of them is a geographic information system or what is often referred to as a Geographic Information System (GIS) (Wibowo, Kanedi, & Jumadi, 2015).

Information Technology

According to McKewon (2001) as cited by Suyanto (2005) Information Technology or IT refers to all forms of technology used to create, change, store and use information in various forms. At the same cite, Willian and Sawyer (2005) describe information technology as any type of technology that helps generate, manipulate, store and communicate or convey information. Technology is then defined as the development and application of tools or systems used to solve problems faced by humans in life, where technology is very closely related to procedures (John, Herawati, & Sunyata, 2013). The data according to Gordon B. Davis (1985) is within the shape of information that has been processed into a form that's more important and valuable for the beneficiary of the data itself for encouraging utilisation to form decisions. The same definition was conveyed by Raymond McLeod (1995) where information is "as data that has been processed into a form that is meaningful to its users" (Lubis & Safii, 2018).

Based on the understanding or definition of information technology, it can be concluded that information technology is the most main choice for building, making and creating an organization's data framework and information system. Till the result that its use, according to Thomson et al (1991) is related to the requirement for utilizing data frameworks to carry out different assignments that use information technology in doing work. Where the indicators are based on the intensity and frequency of utilization, and the number of applications (software) used. Hence the ability of human resources to operate this technology has a significant impact on the process of utilizing information technology itself (Fahdiansyah & Anas, 2017).

The application of information technology in an agency or organization, of course, aims to support and support interests and work. Sutarman (2009) emphasize that the main goal of using information technology is to settle problems, increase creativity and work more effectively and efficiently. The same thing was also conveyed by Jogiyanto (2005) that information technology has a role in an organisation to improve efficiency, effectiveness, communication and competitiveness (John, Herawati, & Sunyata, 2013).

Geographic Information System (GIS)

The Geographic Information System (GIS) according to Prahasta (2019) as quoted by Wibowo, et al (2015) is a system used to collect, integrate and analyse information related to the earth. Where the term geographic information is a combination of systems, information and geography. The term geographic information also refers to information about places located on the earth's surface, the position of an object and information related to information that is known based on position (Wibowo, Kanedi, & Jumadi, 2015). GIS itself has the ability to connect a lot of data using a certain point, combine them and then analyse and map the results. Where the data that is processed is spatial data that has a coordinate system as the basis for reference. So that GIS is able to answer questions related to location, trend, pattern conditions and modelling (Rosdania, Agus, & K, 2015).

Meanwhile, according to Arronoff (1989) GIS is a computer-based system with the ability to cope with geographic data that functions to enter data, data management, including data storage, manipulation, analysis, with the final results that can be used as a reference for decision making, especially data that relating to geography (Abidin, 2015). Hence can be GIS is one part of the Decision Support System (DSS) or Decision Making System, which is a computer-based information system that has a function as a decision support system. This system is based on interactive software that collects or compiles a lot of information that is used to tackle a problem (Kasasiah, Gunawan, Indrananto, & Megawonto, 2012).

This Geographic information system can also be in the form of a Web site that is commonly referred to as a WebGIS. GIS has limited capabilities, specifically on the network, while WebGIS is a cross-platform system, where users can view the information in it with internet access. This application will be integrated with a system database that contains various information related to the location points (Puspitasari, Kholdani, Ramadhani, & Utama, 2020). The same definition was conveyed by Qolis et al (2010) as cited by Ramadhani et al (2016) that WebGIS is a geographic information system with a web base which is a combination of mapping graphics, digital maps and geographic analysis, computer programs and data-based that are interconnected in a web form. Where it is compiled with the principles of input or data input, management, analysis and data representation and the existence of a web server (Ramadhani, Awaluddin, & Nugraha, 2016).

Based on the explanation above, this study aims to develop a Website-based GIS as a monitoring and decision-making method (DSS), especially as an initial study of the RAD-PPM implementation process. Since the implementation of the RAD-PPM which is the implementation of the Minamata

Convention is an obligation of the fulfilment of the Indonesian constitutional mandate. Due to this obligation government should protect the Indonesian citizen from the threat of mercury pollution which is hazardous to human health and environmental sustainability. This study will also look at user acceptance of this WebGIS, specifically the extent to which this application can be used by users and how effective it is in delivering information related to small-scale gold mining in Kulon Progo. The use of a website-based information system as a process of implementing RAD–PPM in Kulon Progo is in line with Minister of Environment and Forestry regulations No. P81/MENLHK/ KUM.1/ 10 of 2019 Article 19 stipulates that the results of monitoring, evaluation and reporting of mercury reduction and elimination through the information system with details as follows:

A. Regional profile in the form of geographical conditions, including population demographics and people's livelihoods,
B. Data and information regarding ASGM business and/or activities, as well as
C. Implementation of Mercury elimination activities in RAD – PPM.

This study is expected to be used as a medium for monitoring and evaluating environmental management. Where this is in line with the Presidential Regulation of the Republic of Indonesia Number 27 of 2014 that concerns the National Geospatial Information Network. It is stated that geospatial information is needed at all levels and aspects of government, especially to improve the quality of national decision-making.

METHOD

This research is a Research and Development research, which is a type of research that aims to develop applications, which are used as a tool for decision making-a Decision Support System (DSS). The data collected is in the form of the coordinates of the mine location to the regional profile including the profile of the distribution of mercury in gold mining. With a descriptive qualitative method, where qualitative research uses intensive and extensive methods in data collection. Specifically by analyzing related documents, interviews with related actors (government, local groups and communities), Focused Group Discussions and site surveys with the to collect coordinates and direct surveys to see activities and processes that occur in the field directly (Slamet, 2019).

Whereas the data analysis technique used in this study is as stated by Miles and Huberman (1992), videlicet the interaction between data collection, data reduction and data presentation and drawing conclusions. According to Rijali (2018), data reduction is an effort to conclude data. Furthermore, data sorting, which is then clarified by Agusta (2003) regarding data reduction; classifying, directing, discarding unnecessary and organizing data or in other words simplification of data (Agusta, 2003). While the presentation of data collects information obtained and neatly arranged, which has the potential to be used as conclusions (Rijali, 2018).

The research location related to the preparation and development of a website-based information system or WebGIS as the use of information technology in the implementation of the RAD-PPM is in Kalirejo and Hargorejo, Kokap, Kulon Progo, Special Region of Yogyakarta. The server used in the preparation of the WebGIS is Esri. Kulon Progo is the only regency in the Special Region of Yogyakarta that has gold potential and is a centre for mining, processing and refining gold. It is estimated that there are 5,887 tons of gold found in the Kokap District, Kulon Progo.

This study also uses the System Usability Scale (SUS) calculation to see the extent to which WebGIS can be accepted and used effectively. According to Nielsen (2012) in Aprilia et al (2015), usability is used to assess the quality and how easy this interface system is used by the user. With the result that, a questionnaire is used to measure the usability of the system from the user's point of view (Aprilia, Santoso, & Ferdiana, 2015).

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RESULT AND DISCUSSION

Data Collection and Analysis

Secondary data collection was carried out by studying literature from previous studies. This data collection refers to a Secondary data collection refers to the Minister of Environment and Forestry regulations No. P81/MENLHK/KUM.1/10 the Year 2019. The data, especially in priority areas of Small-Scale Gold Mining with data and information, including regional profile, number and location of gold mining, distribution of mercury, mercury poisoning cases, gold management locations, and alternative gold management technologies. While the primary data collection is done by collecting Archives (Documents), Direct Observations (observation-field visits) including the collection of my site coordinates, in-depth interviews (in-depth interviews) and Focus Group Discussions (FGD). This data collection is also intended to collect initial information regarding the ASGM sector, including its various development potentials. Archives or documents collected for secondary data collection are in the form of data of the exploration of gold potential in Kokap, Kulon Progo, as well as the technical part of RAD-PPM Kulon Progo Regency, especially in the ASGM sector.

Profile of Kalirejo and Hargorejo

Kalirejo is a village located in the Kokap sub-district, Kulon Progo district, Yogyakarta Special Region. According to the village and local information, the general Bina village government, Ministry of Home Affairs, this area is about 1,295.15 ha, which is located at the coordinates of 07° 49' 44" LS 110° 03' 53" east longitude.

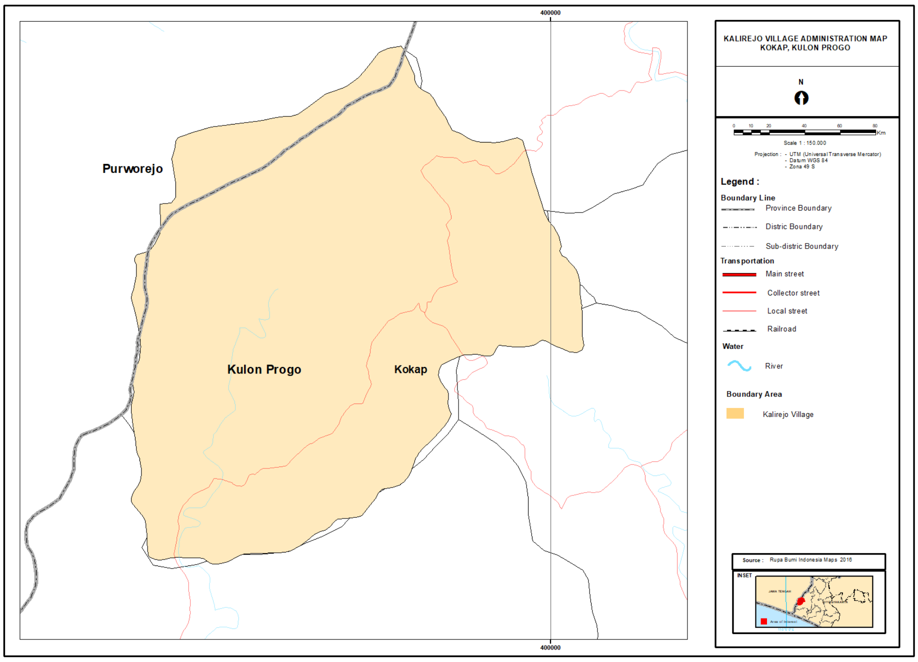

Figure 1. Administrative maps of Klairejo

Kalirejo is located on the southern slopes of the Menoreh hills with a height of land is 400 to 600 meters above sea level, with 9 hamlets videlicet Kalibuko I, Kalibuko II, Papak, Sangon I, Sangon II, Sengir, Plampang I, Plampang II and Plampang III. While the topography of the highland area, Kalirejo has an average annual rainfall of around 2000 to 2600 m^3, with an average temperature of 23 °C to 26 °C.

Whereas Hargorejo is located in the Kokap District, Kulon Progo, Special Region of Yogyakarta. The area of this village is 1,543.45 hectares with regional coordinates at 070 52' 16" LS 1100 06' 38"

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east longitude and consists of 16 hamlets, namely: Padukuhan Anjir, Mount Kukusan, Mount Rego, Kliripan, Krengseng, Kriyan, Ngaseman, Ngulakan, Pandu, Penggung, Sambeng, Sangkrek, West Selo, East Selo, Sindon, and Tejogan.

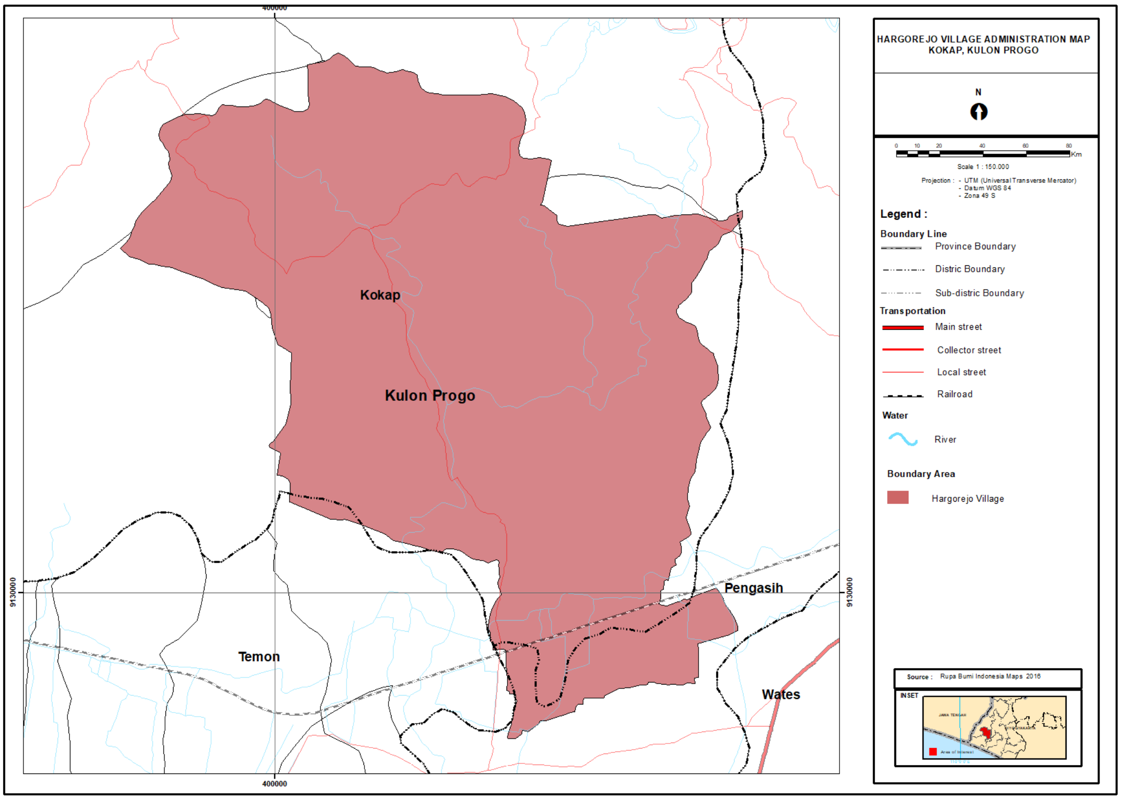

Figure 2. Administrative maps of Hargorejo

Where most of the area of Hargorejo Village is a mountainous zone called Menoreh Hill so that the topography of this area is a plateau at an altitude of approximately 113 meters above sea level. The average temperature in Hargorejo village is around 36oC to 43oC, with an average rainfall of about 2000 to 2500 m3 per year.

Demographics of Kalirejo and Hargorejo

The total population of the Kalirejo is 4,857 people with 2,446 men and 2,411 people (2020). There are 1,314 families in the category of underprivileged families, 90 families in the category of prosperous families 1, 14 families in the category of prosperous families 2, and 18 families in the category of prosperous families 3. As for education, based on data from village data in semester 2 of 2020, the education level is at least The highest level is at Strata I level with a total of 60 people, 20 Diploma III graduates, 13 Diploma I/II graduates, 945 high school graduates, 1,083 junior high school graduates, 469 elementary school graduates and 891 people who have/not attended school.

The population in Hargorejo based on data in 2020 is around 10,852 people, with a population density of around 703 people/km2. Hargorejo, based on data from the Central Statistics Agency, is a village that has a poverty rate above 30%. The largest livelihood of the residents of Hargorejo is farming, reaching 67% of the total population (Section for Development and Empowerment of Hargorejo Village, 2019). Whereas the education of the community, according to the 2020 semester 2 update, there are 319 people who are undergraduate graduates or equivalent, 150 people who are D-3 graduates, 1,662 people who are high school graduates (equivalent) and there are about 126 people who have never received an education.

Natural Resource Potential

The Kalirejo and Hargorejo which are located on the slopes of the Menoreh Mountains have abundant natural resource potential, including mineral content such as gold and andesite. Moreover, it has other natural products such as durian, langsep, mangosteen, avocado and wood and bamboo. Other agricultural products can also be found in Hargorejo such as chilli, corn, green beans and rice.

Based on the analysis of ore at Kokap conducted by Gunawan et al (2001) in a technical study of the Regional Action Plan for the Reduction and Elimination of Mercury (RAD-PPM) Kulon Progo District in 2021, gold and silver are randomly distributed in quartz veins with a content of around 1-13 .8 ppm Au and 5.4-63.2 ppm Ag and analysis conducted by Harjanto et al (2009), found at least 0.1 – 0.42 ppm Au in rocks and 0.52-1.45 ppm Au in quartz veins with the highest levels are in the Sangon, Plampangan, Gabus and Mount Kukusan Padukuhan areas (Kulon Progo Regent Regulation Number 18 of 2021 concerning Regional Action Plans for the Elimination of Mercury, 2021).

The data for the Final Report for the Preparation of Detailed Exploration of the Artisanal Gold Mining Area in the Kokap sub-district in 2017 by the Department of Public Works, Housing and Mineral Resources Special Region of Yogyakarta, emphasize that there are at least four blocks in the area of the Kokap region that contains gold, namely Block 1 Sangon, Block 2 Plampang II, Block 3 Plampang III and Block 4 Kukusan Mountain.

Table 1. Estimation of Gold Reserves in Kokap, Kulon Progo Regency

BLOK	Coordinate	Estimated Gold Reserve	Parameter
Block 1 Sangon	S 7º 50' 23.9" E 110º 4' 9.8"	Andesite contains gold: 1,593 million tons so there are about 18,404 tons of gold	Au: 11,553 ppm
	S 7º 50' 8.1" E 110º 4' 12.2 "		Ag: 8,614 ppm
	S 7º 50' 18.5" E 110º 4' 15.5"		Cu: 71,597 ppm
	S 7º 50' 15.1" E 110º 4' 13.8"		Pb: 265,91 ppm
Block 2 Plampang II	S 7º 49' 49.2" E 100º 4' 3.7"	Andesite containing gold: 863,925.84 tons so there are about 8,888 tons of gold	Au: 10,288 ppm
	S 7º 49' 49.5" E 110º 4' 10.4"		Ag: 23,605 ppm
	S 7º 49' 35.9" E 110º 4' 24.9"		Cu: 357,408 ppm
	S 7º 49' 38" E 110º 4' 12.3"		Pb: 11877,58 ppm
Block 3 Plampang III	S 7º 48' 57.3" E 110º 4' 51.7"	**West:** Andesite contains 459,000 tons of gold so there are about 5,283 tons of gold. While in the **East** there are 702,000 tons of andesite containing gold, so there are around 14,259 tons of gold	Au: 11,510 ppm (West), 20,312 ppm (East)
	S 7º 48' 57.3" E 110º 4' 53.1"		Ag: 26,718 ppm (West), 22,839 ppm (East)
	S 7º 49' 5" E 110º 4' 23.3"		Cu: 126,085 ppm (West), 244,146 ppm (East)
	S 7º 48' 54.9" E 110º 4' 31.5"		Pb: 394,305 ppm (BARAT), 477,743 ppm (TIMUR)
Block 4 Gunung Kukusan	S 7º 50' 26.6" E 110º 5' 26.2"	Andesite containing gold is 189,000 tons, so there are around 2,428 tons of gold	Au: 12,845 ppm
			Ag: 11,847 ppm
			Cu: 100,896 ppm
			Pb: 56,167 ppm

Meanwhile, regarding water resources, based on data from the Village Information and Local Jendral Bina Village Government Ministry of Home Affairs in 2014, the number of springs in Kalirejo

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was 57 springs and currently, many springs is closed due to the impact of sedimentation from andesite mining. This spring is used by around 604 families with a good condition ratio of 10, 60. Kalirejo village also has 13 reservoirs and 20 river points which are still actively used by the community. As for the village of Hargorejo, there are 71 units of springs in good condition that are used by more than 120 families.

Apart from the potentials mentioned above, based on information on the village profile of Kalirejo and Hargorejo also have natural tourism potential. Kalirejo has two tourism potentials, namely Mount Agung with an area of about 1,295.96 hectares and Mount Ijo located in Plampang 1. Meanwhile, the Hargorejo tourism potential from the data of the Development and Empowerment Section of Hargorejo stated have quite a lot of tourism potential:

a) Kliripan Manganese Ex-Mining Educational tours in Kliripan, Penggung, Anjir, and Kriyan;
b) Anjir Field Campground in Anjir;
c) Nature Tourism of Mount Kuniran in Pandu;
d) Sunan Geseng Petilasan Cultural Tour in Ngulakan
e) Nature Tourism of Kedung Lewung Valley, Tejogan

Unfortunately, the tourism potential still has limited information, especially the location on Google Maps, making it difficult to identify wider tourism potential and known by the public.

Gold Mining Site

The data that related to gold mining locations were obtained from secondary data from previous research, as well as primary data from direct visits to retrieve location coordinates using GPS. In Kalirejo, people's gold mining locations are the most active in Kapanewon Kokap, namely in 4 gold mining areas: Sangon 1, Sangon 2, Plampang II and Plampang III hamlets. Based on research conducted by Santoso and Gomareuzzaman in 2018, there are four gold mining locations, specifically:

Table 2. Coordinates of mine site

No	Koordinat	Nama Daerah	Komoditas Tambang
1	X: 397500, Y: 9134600	Dusun Plampang 1, Desa Kalirejo, Kec. Kokap, Kab. Kulon Progo	Emas
2	X: 397488, Y: 91346677	Dusun Plampang 1, Desa Kalirejo, Kec. Kokap, Kab. Kulon Progo	Emas
3	X: 398047, Y: 9136023	Dusun Plampang 2, Desa Kalirejo, Kec. Kokap, Kab. Kulon Progo	Emas
4	X: 0398027, Y: 9136023	Dusun Plampang 2, Desa Kalirejo, Kec. Kokap, Kab. Kulon Progo	Emas
5	X: 397472, Y: 9133239	Dusun Papak, Desa Kalirejo, Kec. Kokap, Kab. Kulon Progo	Emas

In 2020, there is one ASGM location in Kokap District that already has an Artisanal Gold Mining Permit (IPR) located in Plampang III, Kalirejo. In addition, there are other ASGM locations that do not yet have an IPR located in Plampang I, Plampang II, Sangon I, Sangon II and Papak located in Kalirejo and Gunung Kukusan located in Hargorejo. Moreover, there is one gold management location in Plampang II. Where based on the data from technical studies in the Kulon Progo RAD-PPM in the ASGM sector in Kokap, stated that there are several spindles units used in the gold management process.10 units of spindles in the Sangon 2, 1 unit in the Plampang 3, 36 units in the Plampang 2 and 6 units in the Sangon 1.

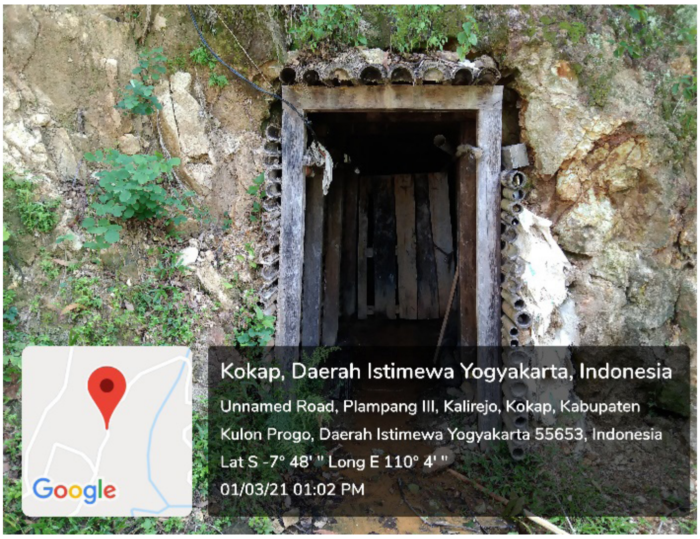

Figure 3. Plampang III Gold Mine Location (Personal Documentation)

Figure 4. Plampang II Gold Mine Location (Personal Documentation)

Distribution of Mercury Contamination in Environment

Mercury (Hg) is a silvery heavy metal that is liquid at room temperature (Suoth, Masitoh, Harianja, Junaidi, & Purwati, 2020) and one of kind toxic metal because it cannot be decomposed or destroyed by organisms in the environment. Hg metal will accumulate in the environment and can settle and form complex compounds with organic and inorganic materials (Setiyono & Djaidah, 2012). Its nature that accumulates in the environment causes contamination, and this contamination can further interfere with human health for a very long term period (Krisnayanti & Probiyantono, 2020). The use of mercury in ASGM was chosen because mercury can be used easily and quickly in the gold extraction process, is quite effective and efficient in binding gold (even in various mining conditions), and is very easy to obtain and sell at relatively low prices. That is the reason the ASGM sector becomes the largest contributor to mercury emissions, reaching 35% of the total mercury emissions. The assumption of mercury release to the environment is when miners release between one and two grams of mercury per-one gram of gold. China occupies the first position as a major contributor to mercury emissions from the ASGM sector, which is around 200-250 tons/year, while Indonesia is at 100-150 tons/year (Veiga, Maxson, & Hylander, 2006).

Small-scale gold mining in Kokap was carried out using an amalgamation process using mercury, which has been going on since the 1990s (Sumarjono, Nusanto, Suyono, & Sukamto, 2019). Gold mining in Kokap at the beginning of its emergence was carried out in a very simple way. The amalgamation method was first used by miners from Tasikmalaya, West Java. In one location, gold ore management uses 1 to 10 amalgams, where each coil can manage 15 or even 25 kg of ore in a day. The ore that has been piled up will then be put into a coil that has been given water, mercury and cement which will then be rotated by a generator. Unfortunately, tailings containing mercury are simply dumped into the environment. It is at this stage that mercury pollution from mining enters the environment, namely from spilt tailings (Banunaek, 2016).

The study conducted by Setiabudi in 2005 showed that mercury levels in the tailings ranged from 800 to 6900 ppm Hg and mercury in the soil was found to be around 50 ppm Hg, while in river sediments that flow close to the management site, 0.1 to 97.84 ppm Hg (Setiabudi, 2005). Another study by Banunaek in 2016 stated that mercury levels in the soil ranged from 0.30 to 22.51 mg/kg, and in tailings, the mercury concentration was found to be quite high, namely 164.16 to 383.21 mg/kg, where it has exceeded the quality standard of the Minister of the Environment No. 202 of 2004 which is 0.005 mg/kg (Banunaek, 2016). This is in line with the research conducted by Akbar in 2016 as cited in the technical study of RAD-PPm Kulon Progo Regency, namely from five sampling points around ASGM in Kalirejo in water and sediment found around 0.0004 to 0.0020 ppm at the water, while in the soil it reaches 1.1410 ppm at locations close to gold management sites (REGULATION OF THE REGENT OF KULON PROGO NUMBER 18 the YEAR 2021, 2021).

Based on research and studies conducted since 2005, it can be concluded that the distribution of mercury contamination still exists around the gold processing in Kokap, although mercury management has now been reduced and stopped.

Utilization of WebGIS

The secondary and primary data obtained is then entered and integrated into a Website-based Geographic Information System. The data is arranged by types, such as in the form of profile data, potential to the point of gold mining locations and the distribution of mercury contamination around ASGM locations. These data are preliminary data, which can be used for decision making and policy considerations related to the RAD-PPM implementation process in Kulon Progo Regency, especially in the ASGM sector, by looking at the location and pattern based on research that has been carried out annually.

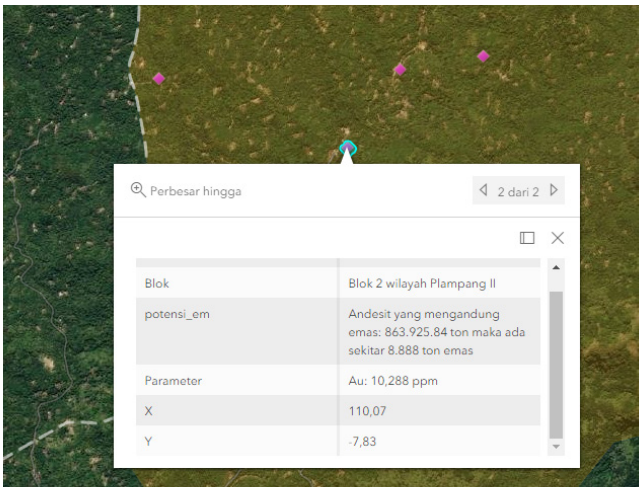

Figure 5. Display of gold content information on WebGIS

The picture above shows the block location in the Kokap area as well as a piece of information on gold content. Where this information can be used for the process of obtaining Artisanal gold mining permits and controls for opening new mining pits, in order to decrease the damage to other lands that can be used for other activities. The information related to the distribution of mercury content can also be used as initial data for further research and mapping of the distribution of mercury over a certain period of time. Where based on previous studies, it can be mapped to see the distribution pattern. Based on the mapping method, it can be seen how far and vast the contamination content from the gold processing process in ASGM. Later this data can be used and supported as a reference for the process of returning and improving the environment (remediation). As of the development of other potentials around the ASGM area can be carried out properly and sustainably.

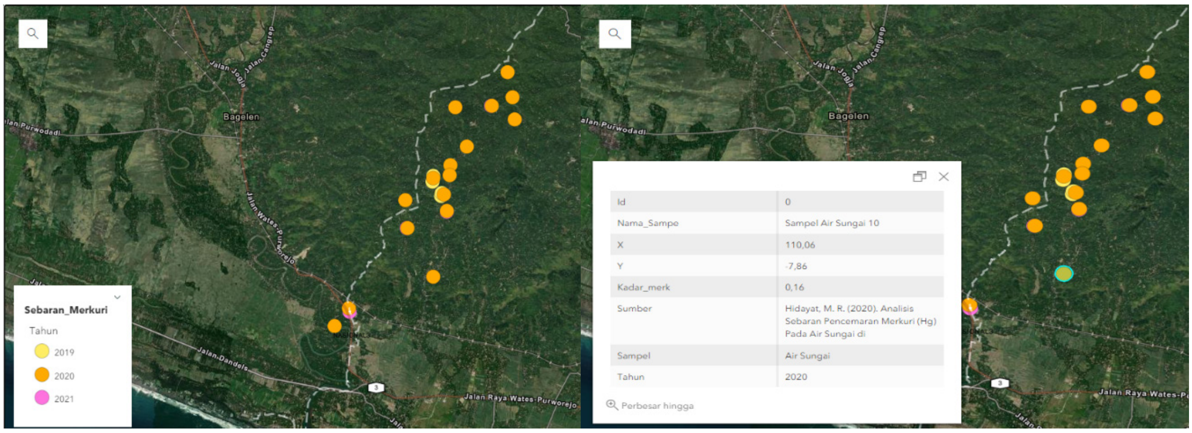

Figure 6. Mercury contamination distribution point display on Web GIS

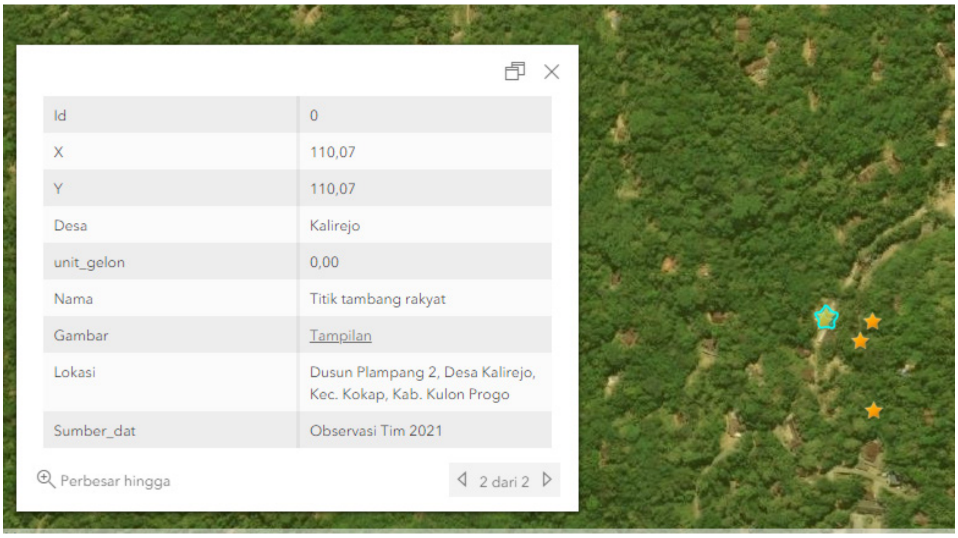

Figure 7. Gold-Mine location coordinate view on WebGIS

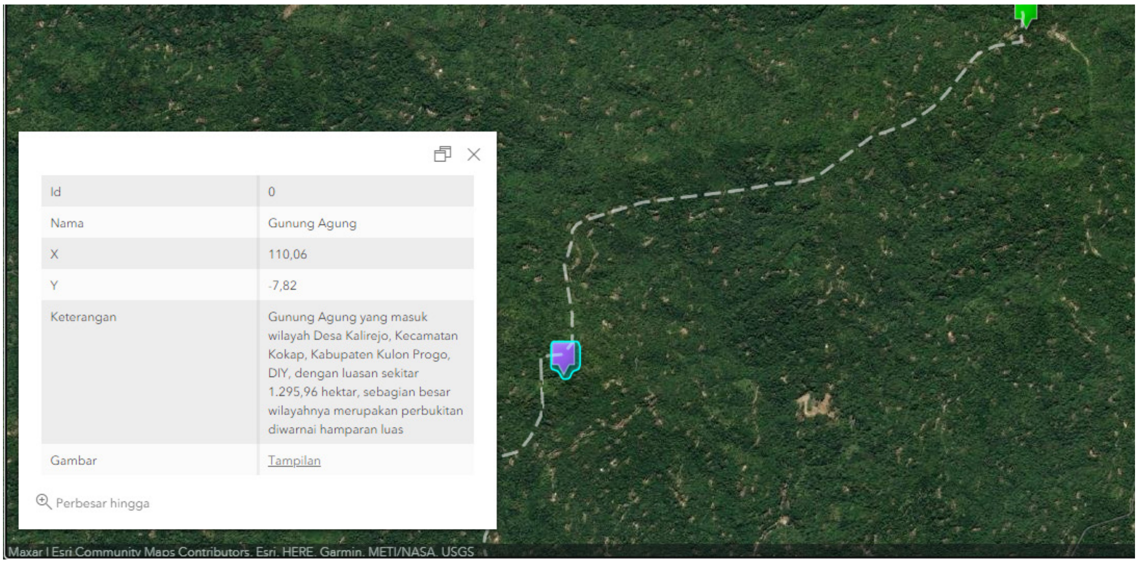

Figure 8. Display of potential coordinate point locations for Kalirejo tourism on WebGIS

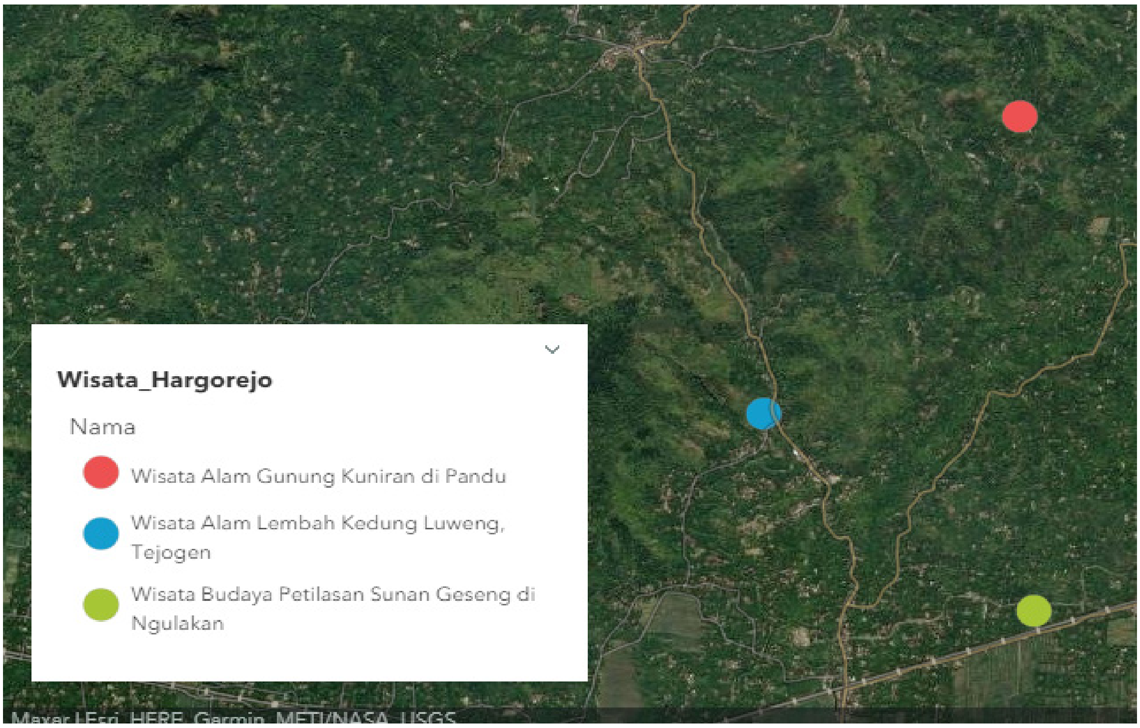

Figure 9. Display of potential coordinate point locations for Hargorejo tourism on WebGIS

Besides information related to mine location by coordinate, potential to the distribution of mercury content of contamination in WebGIS. Other information related to the potential of natural resources, tourism and geographic conditions in Kokap can also be used as initial data for regional development apart from gold. This is in line with the strategic plan for implementing the RAN-PPM, specifically diverting the livelihoods of local communities around ASGM (Krisnayanti & Probiyantono, 2020). Information related to gold mining locations and the distribution of mercury will then facilitate the process of structuring tourist sites and other locations such as public facilities to plantations. This arrangement is in line and matches with the regional development process, especially from a socio-economic perspective (Mahi, 2016).

Usability Evaluation

The SUS calculation system in this study used a questionnaire with 10 questions with 30 respondents (R) from academia, researchers and related institutions to determine the response and level of satisfaction with the WebGIS. This questionnaire uses a 5-point Likert scale: Strongly Agree (SA-5 points), Agree (A-4 points), Neutral (N-3 points), Disagree (DS-2 points) and Strongly Disagree (SDS-1 points). The questionnaires given are as follows:

Table 3. Questionnaire Question

Q1	Is the information that available in WebGIS easy to understand?
Q2	Are the features in the application easy to use?
Q3	Does WebGIS meet your information needs?
Q4	Can WebGIS be used as a reference in determining programs or policies?
Q5	Is the use of WebGIS satisfactory?
Q6	Is this WebGIS useful for users?
Q7	Is WebGIS easy to operate?
Q8	Is this WebGIS easy to learn for users who use it for the first time?
Q9	Is the Information in WebGIS accurate?
Q10	Is this WebGIS trustworthy?

Based on the results of the questionnaire obtained, the usability test analysis was carried out, the results of which are presented in the following table:

Table 4. SUS calculation results

R	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score SUS	Average
1	4	4	4	4	4	4	4	4	4	4	40	100
2	4	4	4	4	4	4	4	4	4	4	40	100
3	5	5	4	4	5	5	4	4	5	5	46	115
4	3	4	4	4	4	4	3	2	3	3	34	85
5	3	4	3	3	4	3	3	4	4	4	35	87.5
6	4	3	4	4	4	4	4	4	4	4	39	97.5
7	4	4	4	4	4	4	4	3	4	4	39	97.5
8	3	4	3	3	3	4	4	4	4	4	36	90
9	4	4	4	4	4	4	4	4	4	4	40	100
10	4	4	5	5	4	4	4	4	4	4	42	105
11	5	5	4	4	5	5	5	5	5	5	48	120
12	5	4	3	3	3	4	4	4	3	3	36	90
13	4	4	4	4	4	5	4	3	4	4	40	100
14	5	5	5	5	4	4	5	4	4	4	45	112.5
15	4	4	4	4	3	4	4	3	4	4	38	95
16	4	3	2	2	3	5	3	3	3	3	31	77.5
17	4	4	4	4	4	4	4	4	4	4	40	100
18	4	4	5	5	4	4	4	4	4	4	42	105
19	4	4	4	4	4	4	4	4	4	4	40	100

20	5	4	4	4	5	5	4	4	4	4	43	107.5
21	4	4	4	4	4	4	4	5	4	4	41	102.5
22	4	4	4	4	4	4	4	4	3	3	38	95
23	4	4	4	4	4	5	5	4	4	4	42	105
24	4	5	4	4	4	4	4	4	4	4	41	102.5
25	5	4	4	4	5	4	4	4	5	5	44	110
26	4	4	4	4	4	4	4	4	4	4	40	100
27	4	4	4	4	4	4	4	3	4	4	39	97.5
28	4	4	4	4	4	4	4	4	4	4	40	100
29	4	4	3	3	4	4	4	4	4	4	38	95
30	4	4	3	2	3	3	3	3	3	3	31	77.5
Total											1188	
Total Average												99

Table. 4 above shows the results of the calculation of the respondent's SUS Score, which is 1188. Based on the calculation scale the WebGIS of ASGM in Kulon Progo is included in the Marginal Higher Acceptable category. With an average value of 99, the WebGIS created in this study is also included in the category A grade scale and adjective rating Best Imaginable.

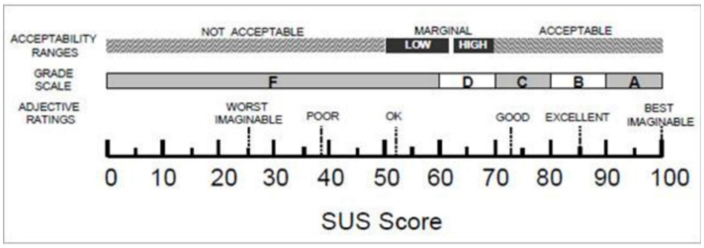

Figure 10. SUS Calculation Result Scale (Brooke, 2013)

CONCLUSION

Utilization of a Website-based Information System or WebGIS, besides being a medium for monitoring and implementing the Regional Action Plan related to Mercury Reduction and Elimination, as well as being a platform of information for miners and the wider community, since it can be accessed using the internet. This information system is also included in the process of implementing the National Action Plan related to Mercury Reduction and Elimination (RAN-PPM) in Presidential Regulation Number 21 of 2019 which is stated in Article 19, the need for an information system as an integrated monitoring and evaluation system in efforts to reduce and eliminate mercury. According to the calculation results of the WebGIS System Usability Scale for Small-Scale Gold Mining in Kulon Progo Regency with respondents from related agencies and academics or researchers, WebGIS is included in the category of applications that can be accepted by users and is quite appropriate. Nevertheless, synergy and cooperation between various agencies, especially those directly related to the ASGM sector in the process of improving and developing this WebGIS as stated in the mercury reduction and the elimination strategy plan is necessary. The information can also be expanded widely, including the potential for regional development, based on data on the education level and occupation of the population referring to socio-economic data. Thus, further research will mutually support an effective and efficient implementation process.

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REFERENCES

Abidin, A. Z. (2015). Konsepsi Sistem Pendukung Keputusan Spasial (Spasial Decision Support System) Untuk Bidang Pendidikan Berbasis Jaringan Data Spasial Nasional Dalam Rangka Perencanaan Pembangunan Pendidikan Nasional Secara Berkelanjutan. Jurnal Teknologi Informasi dan Komunikasi ATMIK Subang, 1-14.

Agusta, I. (2003). Teknik Pengumpulan dan Analisis Data Kualitatif. Pelatihan Metode Kualitatif Pusat Penelitian Sosio Ekonomi Litbang Bogor, 1-11.

Aprilia, I., Santoso, P. I., & Ferdiana, R. (2015). Website Usability Testing using System Usability Scale. IPTEK-KOM Vol. 17, No. 1, 31-38.

Banunaek, Z. A. (2016). Pencemaran Merkuri di Lahan Pertambangan Emas Rakyat dan Strategi Pengendaliannya . Tesis Institusi Teknologi Sepuluh November , 1-116.

Brooke, J. (2013). SUS: A Retrospective. Journal of Usability Studies Archive, 29-40.

Darajati, W. (2016). Upaya Pencapaian Target Tujuan Pembangunan Berkelanjutan (TPB) Indonesia . Kementerian PPN/Bappenas.

Emas, R. (2015). The Concepts of Sustainable Development: Definition, and Defining Principles. Brief for GSDR, 1-3.

Fahdiansyah, R., & Anas, A. S. (2017). Teknologi Informasi Sebagai Penunjang Perkembangan Sistem Informasi dalam Akuntansi. Simposium Nasional Teknologi Terapan (SNTT) 5 , 246-253.

Kasasiah, A., Gunawan, T., Indrananto, C., & Megawonto, R. (2012). Pengembangan Decision Support System Sebagai Penunjang Pengelolaan Konservasi Perairan Indonesia. Konferensi Nasional VIII Pengelolaan Pesisir, Laut dan Pulau-Pulau Kecil (pp. 1-9). Mataram: Direktorat Konservasi Kawasan dan Jenis Ikan, Dirjen KP3K-KKP.

Krisnayanti, B. D., & Probiyantono, A. S. (2020). Buku 1: Kebijakan Pengurangan dan Penghapusan Merkuri di Indonesia . Jakarta: GOLD-ISMIA.

Kristianingsih, Y. (2018). Bahaya Merkuri Pada Masyarakat di Pertambangan Emas Skala Kecil (PESK) Lebaksitu. Jurnal Ilmiah Kesehatan Vol. 10 (1), 32-38.

Lubis, I., & Safii, M. (2018). Smart Economy Kota Tangerang. Tangerang Selatan: PT. Karya Abadi Mitra Indo.

Mahi, A. K. (2016). Pengembangan Wilayah: Teori dan Aplikasi. Jakarta: Kencana.

Mensah, J. (2019). Sustainable Development: Meaning, History, Principles, Pillars, and implications for Human Action : Literature Review. Cogent Social Sciences 5:1, 1-12.

PERATURAN BUPATI KULON PROGO NOMOR 18 TAHUN 2021 . (2021). Daerah Istimewa Yogyakarta: Bupati Kulon Progo.

Peraturan Bupati Kulon Progo Nomor 18 Tahun 2021 Tentang Rencana Aksi Daerah Penghapusan Merkuri. (2021).

Puspitasari, D. I., Kholdani, A. F., Ramadhani, B., & Utama, T. A. (2020). Pemanfaatan WebGIS untuk Pemetaan Lokasi dan Kondisi Rambu Lalu Lintas Kota Banjarbaru. Jurnal Teknologi Informasi dan komunikasi Volume 11, Nomor 2, 311-323.

RAD-PPM. (2021). Peraturan Bupati Kulon Progo Nomor 18 Tahun 2021 tentang Rencana Aksi Daerah Pengurangan dan Penghapusan Merkuri.

p-ISSN: 2477-3328
e-ISSN: 2615-1588

Ramadhani, H. A., Awaluddin, M., & Nugraha, A. L. (2016). Aplikasi WebGIS untuk Informasi Persebaran Sekolah Menegah Atas dan Madrasah Aliyah di Kabupaten Kudus Menggunakan HERE MAP API. Jurnal Geodesi UNDIP Volume. 5, Nomor 1, 164-173.

RAN-PPM. (2019). Peraturan Presiden Nomor 21 Tahun 2019 tentang Rencana Aksi Nasional Pengurangan dan Penghapusan Merkuri.

Rijali, A. (2018). Analisis Data Kualitatif. Jurnal Alhadharah Vol. 17, No. 33, 81-95.

Rosana, M. (2018). Kebijakan Pembangunan Berkelanjutan yang Berwawasan Lingkungan di Indonesia. Jurnal KELOLA: Jurnal Ilmu Sosial Vol. 1, No. 1, 148-163.

Rosdania, Agus, F., & K, A. H. (2015). Sistem Informasi Geografi Batas Wilayah Kampus Universitas Mulawarman Menggunakan Google Maps API. Jurnal Informatika Mulawarman Vol. 10, No. 1, 38-46.

Santoso, D. H., & Gomareuzzaman, M. (2018). Kelayakan teknis Penambang Emas Pada Wilayah Pertambangan Rakyat (Studi Kasus: Desa Kalirejo, Kecamatan Kokap, Kabupaten Kulon Progo). Jurnal Science Tech Vol. 4, No. 1, 19-28.

Seksi Pembangunan dan Pemberdayaan Desa Hargorejo. (2019). Profil Desa Hargorejo .

Setiabudi, B. T. (2005). Penyebaran Merkuri Akibat Usaha Pertambangan Emas di Daerah Sangon, Kabupaten Kulon Progo, D. I. Yogyakarta. Kolokium Hasil Lapangan-DIM (pp. 1-17). Bandung: Pusat Sumber Daya Geologi.

Setiyono, A., & Djaidah, A. (2012). Konsumsi Ikan dan Hasil Pertanian Terhadapa Kadar Hg Darah. Jurnal Ilmu Kesehatan Masyarakat 7 (2), 110-116.

Slamet, Y. (2019). Pendekatan Penelitian Kualitatif. Yogyakarta: Graha Ilmu.

Sumarjono, E., Nusanto, G., Suyono, & Sukamto, U. (2019). Merkuri Dalam Bijih Emas di Dusun Sangon II Kalirejo Kokap Kulonprogo Daerah Istimewa Yogyakarta. Prosiding Nasional Rekayasa Teknologi Industri dan Informasi XIV (ReTII), 91-97.

Suoth, A. E., Masitoh, S., Harianja, A. H., Junaidi, E., & Purwati, S. U. (2020). Kandungan Merkuri Dalam Beberapa Media Sekitar Penambang Emas Skala Kecil (PESK) di Kalimantan Tengah. ECOLAB Vol. 14, No. 1, 43-52.

Veiga, M. M., Maxson, P. A., & Hylander, L. D. (2006). Origin and Consumption of Mercury in Small Scale Gold Mining . Journal od Cleaner Production 14, 436-447.

Wibowo, K. M., Kanedi, I., & Jumadi, J. (2015). Sistem Informasi Geografis (SIG) Menentukan Lokasi Pertambangan Batu Bara Di Provinsi Bengkulu Berbasis Website. Jurnal Media Infotama Vol. 11, No. 1, 51-60.

Yohanes, Herawati, N., & Sunyata, L. (2013). Strategi Penerapan Teknologi Informasi di Pemerintahan Kabupaten Sintang Provinsi Kalimantan Barat. Jurnal Tesis PMIS-UNTAN-PSIAN, 1-22.