Evaluation of Mapping Program Outcomes Achievements of the Clean Water and Proper Sanitation Programme Utilizing Geographic Information Systems

Aprisia Hidayani[1]; Debby Ratno Kustanto[2*]

[1,2] Department of Public Health, Faculty of Nursing and Public Health, Universitas Prima Nusantara Bukittinggi, West Sumatera, Indonesia

Corresponding Author: Debby Ratno Kustanto[2*]

Abstract: The UPTD Puskesmas Lunto Working Area has a lower percentage of access to clean water and sanitation than other places in Sawahlunto City in 2023, making it an environmental health issue. This study employed GIS to spatially analyze environmental health problems to determine the distribution and position of research objects to evaluate community access to clean water and sanitation. The project aimed to map clean water sources and sanitation in the Working Area of UPTD Puskesmas Lunto, Kecamatan Lembah Segar, Kota Sawahlunto in 2023. Mixed-method research analyzes primary and secondary data. In 2023, 1711 data on household heads' use of clean water sources and proper sanitation were collected from field mapping, RBI maps, and high-resolution Google Earth images for mapmaking and spatial analysis using the overlay method. The study found that clean water and sanitation access varied by location. East Lunto village has the most clean water (82.00%), while Kubang Tangah has the least (61.24%). West Lunto village has the highest proportion of improved sanitation (96.40%), while Kubang Tangah village has the lowest (88.95%). The research locations' geography and population distribution hindered clean water availability and access, preventing clean water supply system integration. Thus, the local government must create protected springs and hygienic latrines for families who have them and a program to deliver clean PDAM water to the community in the UPTD Puskesmas Lunto operating area. Continuous health education is needed to change river defecators' behavior.

Keywords: Sanitation; GIS; Mapping; Clean Water; Proper Sanitation.

I. INTRODUCTION

Improved technology makes information easier to find. Government and corporate agencies plan, monitor, and evaluate development results using GIS (1). Complex health conditions are interconnected. All causes must be considered to solve public health challenges. Many things affect public and individual health. optimum health involves optimum environment, behavior, heredity, and health services. Damage to one element lowers health (2).Environmental health affects health (3). Environmental health is the prevention of disease and health problems from environmental risk factors to build a healthy physical, chemical, biological, and social environment, according to Permenkes No. 2 of 2023 on the Implementation Regulation of Government Regulation No. 66 of 2014. WHO reports that 2.2 billion people require clean water. Sanitation and handwashing are lacking for 4.2 billion and 3 billion, respectively. This shows that billions of people struggle to get clean water and sanitation. PerPAMSI predicts 19.47% of Indonesian homes will get piped water by 2023. An large funding gap for clean water access in Indonesia causes this.

BPS According to 2020-2023 data, 70.97% of West Sumatra Province dwellings have proper sanitation, including 90.18% in Sawahlunto City. In 2023, 93.51% of Sawahlunto City homes used clean water and 78.68% of West Sumatra Province households. Sawahlunto has six clinics. Barangin has two health centers, Sungai Durian and Kolok, and Talawi has one. E-Monev STBM in 2023 and the Health Office of Population Control and Family Planning Drinking Water Facilities Report until June 2023 show that 83.18% of Puskesmas Lunto households have proper sanitation, compared to 86.81%), 84.07%, Sungai Durian (100%), Kolok (87.02%), and Talawi (86.72%). Silungkang 100%, Kampung Teleng 100%, Sungai Durian 100%, Kolok 97.5%, and Talawi 100% use clean drinking water.

Six health centers in Sawahlunto include UPTD Puskesmas Lunto. UPTD Puskesmas Lunto Working Area spans 39.47 km², with 5376 individuals and 1711 families in four villages: West Lunto, East Lunto, Pasar Kubang, and Kubang Tangah (5) 2 drilled wells, 10 unprotected springs, 2 rainwater collecting facilities, 8 non-tap taps, and 3 drinking water depots are clean water sources in the UPTD Puskesmas Lunto Working Area. Still, 5 families drink river water daily. Some people still pour water into the river instead of using latrines due to poor sanitation. River supplies two Sawahlunto City PDAMs. PDAM East Lunto and PDAM Kubang Tangah supply 5,241 Sawahlunto City households with Batang Lunto River water (6). Fix this immediately. In Sawahlunto City, where clean water and sanitation are available, the UPTD Puskesmas Lunto Working Area has 183 diarrhea and 37 stunting cases in children under five.

At the UN General Assembly in September 2015, wealthy and developing nations set 17 2030 goals to improve society. Goals include no poverty, no hunger, healthy and prosperous lives, quality education, gender equality, clean water and sanitation, clean and affordable energy, decent work and economic growth, industry, innovation, and infrastructure, reduced inequalities, sustainable cities and settlements, responsible consumption and production, climate change, ocean and land ecosystems, and peace. SDG 6—Clean Water and Sanitation—covers environmental health, for the 'Analysis of Achievements of Clean Water and Sanitation Program in UPTD Puskesmas Lunto, Kecamatan Lembah Segar Kota Sawahlunto Year 2023,' GIS allows spatial analysis to show the distribution of health problems, allowing related parties to evaluate a health policy more measurably to help overcome health problems and mitigate disease effects.

This matches Meityn Disye Kasaluhe et al. (2022) (9) who utilized GIS to map healthy latrine distribution and public awareness. Sanitation, rubbish management, and other factors may affect residential public health. Dirty places affect public health (10). Settlement studies can be explored using geographic sensing technologies. In 2023, this study mapped clean water and sanitation sources in the Working Area of UPTD Puskesmas Lunto, Kecamatan Lembah Segar, Kota Sawahlunto.

II. RESEARCH METHODOLOGY

The method used in research methodology is mixed methods research, integrating both quantitative and qualitative data inside a single study, hence yielding more comprehensive and nuanced findings. This study utilized data from the 2023 Environmental Health Program Report, comprising 1711 family heads within the UPTD Puskesmas Lunto Working Area. The sample comprised data on the utilization of clean water sources and adequate sanitation from 1,444 out of 1,711 homes in the UPTD Puskesmas Lunto Working Area, as per the 2023 Environmental Health Program Report. This research was performed in the jurisdiction of UPTD Puskesmas Lunto, which is administratively situated within the Lembah Segar Sub-district of Sawahlunto City, West Sumatra Province. This study was performed from 2 October 2024 to 2 November 2024, utilizing data on clean water source usage and adequate sanitation from July 2023. This study utilized two categories of data: main data and secondary data. The methodologies for data collection differ between the two data types; primary data is acquired through direct observation of the research subject at the site, whereas secondary data is sourced from relevant agencies or institutions authorized to gather or supply such information.

As previously stated, primary data is derived from direct observation of the research subject at the research site. This data comprises coordinate information from the research sample, namely the coordinates of the head of the household's residence, the type of water source utilized, and the sanitation conditions of each dwelling. The collected data comprises the coordinates of water sources and the sanitation conditions of residents, particularly focusing on those that are inadequate or fail to meet established requirements. The data gathering methods employed included direct observation, interviews, and documentation within the research region. Data collected was categorized according to hamlets within the research area. The collected coordinate data was obtained using the Universal Transverse Mercator (UTM) projection method using the WGS 84 datum. The projection system and datum are widely utilized due to its usage of metric units, which ease distance-related analysis.

The secondary data utilized originates from many agencies or institutions that facilitate research endeavors, particularly in the development of maps and spatial analysis. This research utilizes secondary data comprising RBI maps and high-resolution Google Earth imagery. The Rupa Bumi Indonesia (RBI) map serves as a foundational map, offering detailed information pertinent to the Indonesian landmass, encompassing the full territory of Indonesia. It is accessible at a medium scale of 1:25,000 for Java and 1:50,000 for regions outside Java. This map is issued by the Geospatial Information Agency (BIG) and includes revisions from 2005 to the present. The RBI map comprises vector data illustrating entities pertinent to research activities, including the locations of settlement points, government offices, schools, roads, rivers, and village administrative boundaries. The RBI map was acquired by downloading it from the official website of the Geospatial Information Agency, namely the Ina-Geoportal website, at no cost.

This research utilized high-resolution Google Earth pictures as fundamental data/maps to offer an overview of the earth's surface state, namely the UPTD Puskemas Lunto Working Area, the designated research site. The utilized data consists of raster images depicting surface conditions captured by Google's satellites, which are periodically updated to facilitate the analysis of temporal changes in land conditions. This Google Earth image was acquired via the SAS.Planet application, a widely utilized tool for obtaining high-resolution satellite imagery at no cost.

III. RESULTS

A. Description of the research location

The research site is the Working Area of UPTD Puskesmas Lunto, situated in the Lembah Segar Sub-district, Sawahlunto City, West Sumatra (Figure 1). The research site is situated at coordinates 0°40'55.66" S to 0°43'31.19" S and 100°43'28.51" E to 100°46'28.56" E. The research site encompasses the western section of Kecamatan Lembah Segar, comprising four villages: West Lunto Village, East Lunto Village, Pasar Kubang Village, and Kubang Tangah Village.
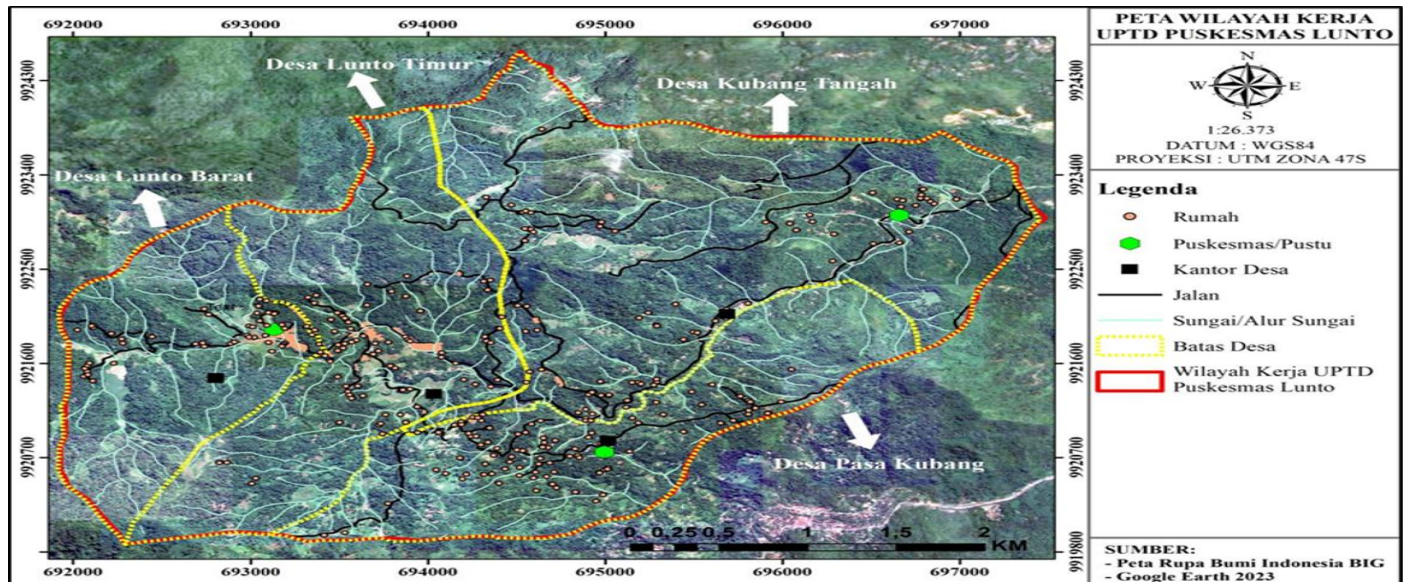
Fig 1 Map of Lunto Health Centre Work Area

The UPTD Puskesmas Lunto Working Area features a predominantly hilly landscape characterized by moderate to steep slopes. Amidst the hills, one can find valleys that possess a relatively narrow shape. In the valley's depths, rivers and creeks flow, with the Batang Lunto River serving as the primary waterway in the UPTD Puskesmas Lunto Working Area. Community settlements are typically found in valley regions, aligning with the distribution patterns of road and river access (Figure 2)
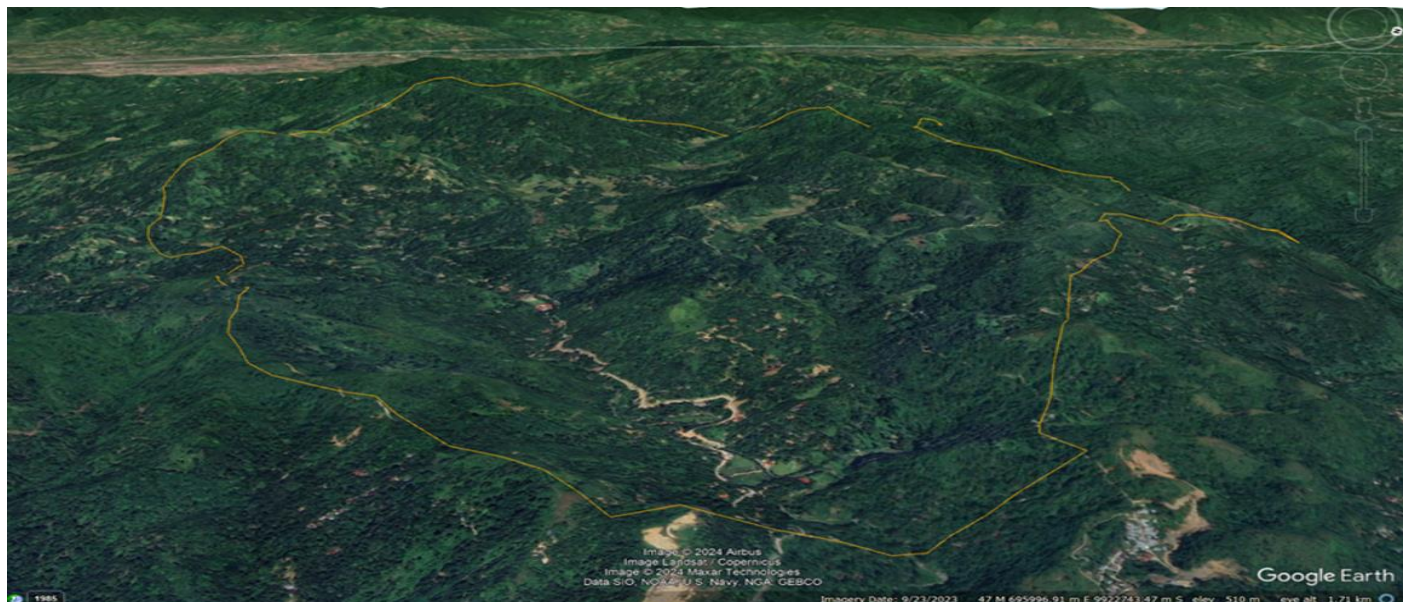

Fig 2 Topographical condition of the research location
(Source: Google Earth Pro)

B. Water Source Facilities

The presence and distribution of water sources are critical for understanding the extent of access and utilization by populations. The distribution of water sources utilized by residents in the UPTD Puskesmas Lunto Working Area was mapped for this purpose. Figure 5.2 illustrates the distribution of water sources within the study area, highlighting six types of water sources frequently utilized by residents. The water sources include PDAM, Pamsimas, springs, dug wells, rainwater harvesting (PAH), and

drinking water depots, which are distributed across each hamlet and village within the UPTD Puskesmas Lunto Working Area. Two PDAM facilities are situated in Kubang Tangah Village and East Lunto Village. Figure 5.3 illustrates that both PDAMs are situated in regions characterized by relatively high population density in each village. The PDAMs are typically situated adjacent to the primary river, specifically the Batang Lunto River, which serves as the water source for both PDAMs. East Lunto PDAM is not utilized by residents, as it is designated to meet the clean water requirements of the population in Sawahlunto City, specifically those outside the Lunto Puskesmas Working Area.
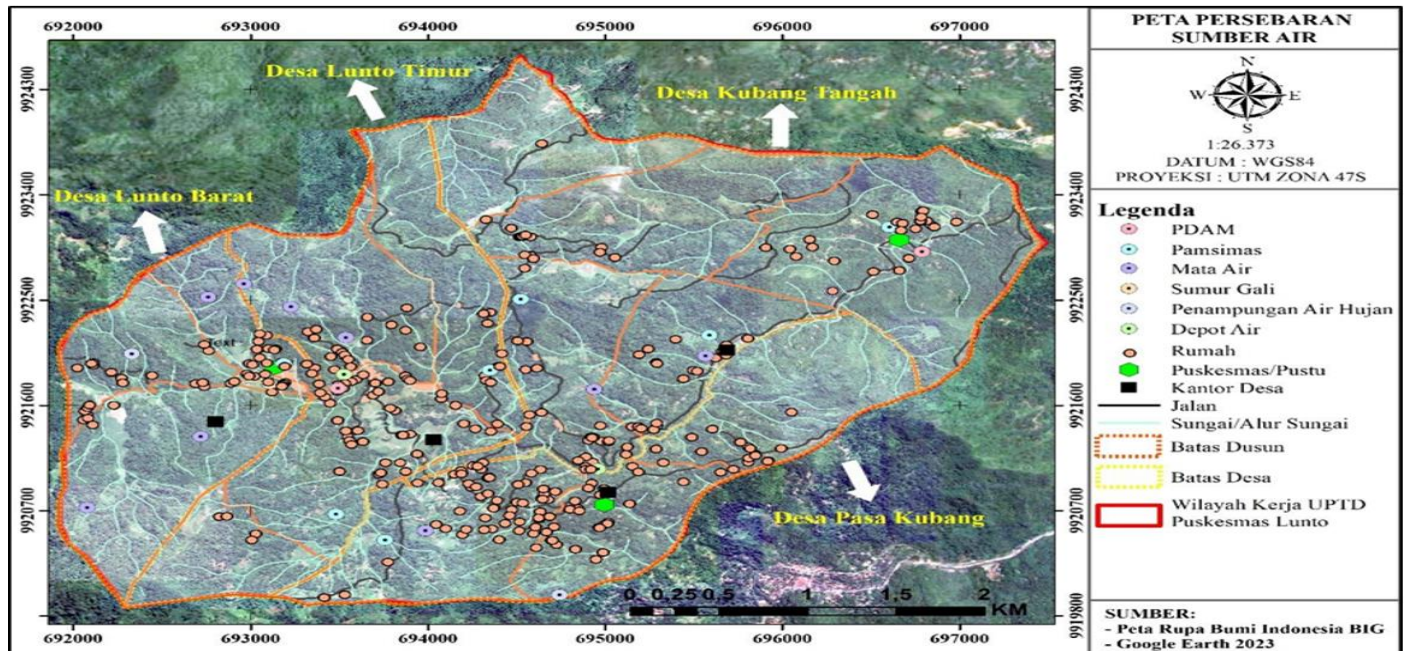

Fig 3 Map of Residents' Water Source Distribution

The UPTD Puskesmas Lunto Working Area contains seven Pamsimas facilities. Kubang Tangah Village hosts three Pamsimas facilities: Gupson Pamsimas, Luak Manih Pamsimas, and Batu Tajam Pamsimas. In Pasa Kubang village, one Pamsimas facility is situated in the Lantiak Malaweh sub-village. East Lunto village hosts two Pamsimas facilities: East Lunto Pamsimas 1 located in Tigo Tingka sub-village and East Lunto Pamsimas 2 situated in Koto Tuo sub-village. West Lunto Village hosts two Pamsimas facilities: West Lunto Pamsimas 1 in Tito Rajo Hamlet and West Lunto Pamsimas 2 in Gunung Medan Hamlet. Figure 5.3 illustrates that the distribution of pamsimas location points is predominantly situated on slopes and in proximity to creeks. The relationship between the distribution of pamsimas and settlements indicates that pamsimas are generally situated at considerable distances from settlements or in areas with low settlement density. Exceptions include Pamsimas Batu Tajam, Pamsimas West Lunto 2, and Pamsimas East Lunto 1, which are in densely populated regions.

The UPTD Puskesmas Lunto Working Area contains seven Pamsimas facilities. Kubang Tangah Village hosts three Pamsimas facilities: Gupson Pamsimas, Luak Manih Pamsimas, and Batu Tajam Pamsimas. In Pasa Kubang village, one Pamsimas facility is situated in the Lantiak Malaweh sub-village. East Lunto village hosts two Pamsimas facilities: East Lunto Pamsimas 1 located in Tigo Tingka sub-village and East Lunto Pamsimas 2 situated in

Koto Tuo sub-village. West Lunto Village hosts two Pamsimas facilities: West Lunto Pamsimas 1 in Tito Rajo Hamlet and West Lunto Pamsimas 2 in Gunung Medan Hamlet. Figure 5.3 illustrates that the distribution of pamsimas location points is predominantly situated on slopes and in proximity to creeks. The relationship between the distribution of pamsimas and settlements indicates that pamsimas are generally situated at considerable distances from settlements or in areas with low settlement density. Exceptions include Pamsimas Batu Tajam, Pamsimas West Lunto 2, and Pamsimas East Lunto 1, which are in densely populated regions.

There are two dug wells, both of which are in West Lunto Village. There are three drinking water depots (DAM) facilities, namely Hafizah Bening Depot (West Lunto Village), AA Tirta Depot (East Lunto Village), Maju Bersama Depot (Kubang Tangah Village). In total, 1706 households have access to water sources, while the remaining 5 households obtain water directly from the river, in this case Batang Lunto River. The use of ponds and non septic tank goosenecks as sanitation facilities is dominant, with settlements using these types of sanitation concentrated around Batang Lunto River. In Dusun Sawah Pulau, residents tend to use healthy latrines. In Tanung Medan Hamlet, the use of healthy latrines is more dominant than ponds and non-septic tank goosenecks.
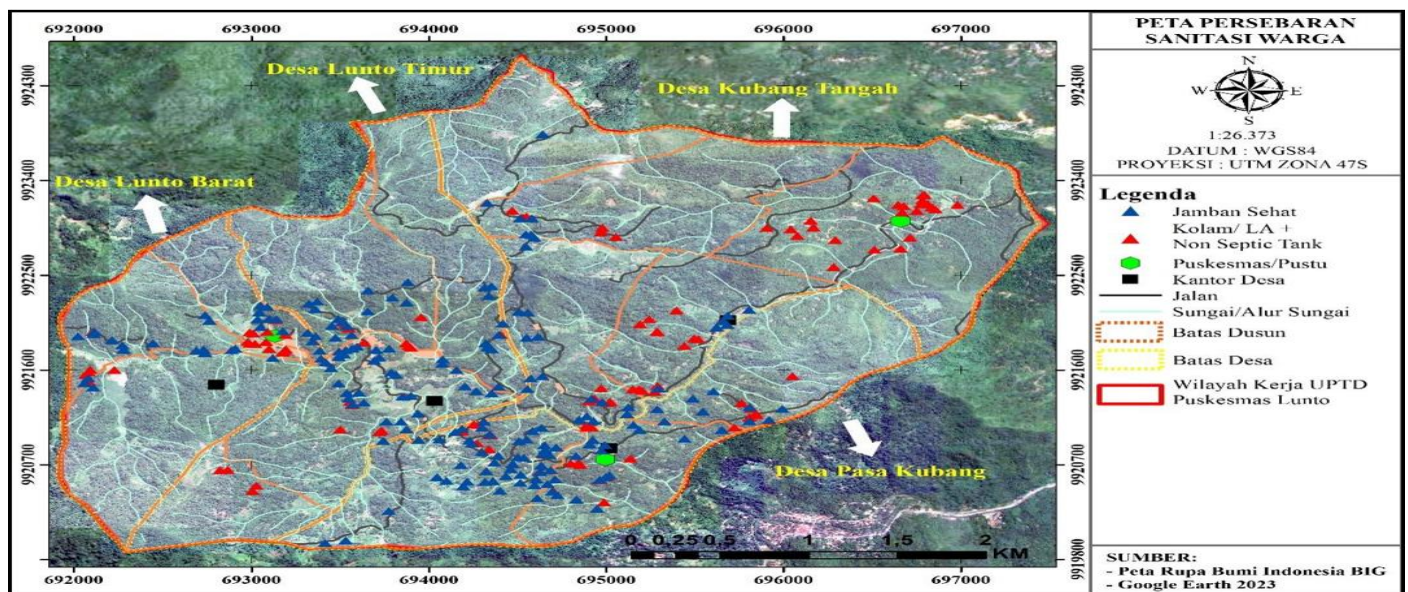
C. Proper Sanitation

Fig 4 Map of Sanitation Distribution

In general, residents of each hamlet in East Lunto Village have adopted healthy latrines for sanitation, except for Simotuang Hamlet, where ponds and swan necks without septic tanks are predominantly used. In Koto Tuo Sub-Village, non-septic swan necks and ponds are distributed randomly, except for the eastern part of the sub-village near the border with Guguak Palam Sub-Village, where these features are clustered together. As one travels further north to Guguak Palam Hamlet, the prevalence of healthy latrine usage rises. In Tigo Tingka Hamlet, residents do not utilize ponds or non-septic swan necks for sanitation purposes.

In Kubang Tangah Village, the prevalence of ponds and swan necks without septic tanks is notable, with only 2 out of 5 hamlets primarily utilizing healthy toilets as sanitation facilities, specifically Sionsek Hamlet and Polak Datar Hamlet. In the Polak Datar sub-village, individuals utilizing ponds and non-septic swan necks are typically found near the borders with other sub-villages and villages. This is not the case in the area adjacent to East Lunto Village, where all residents employ healthy latrines as their sanitation facilities. In the Guguak Pauh sub-village, the three types of sanitation are utilized in a nearly balanced manner, with the eastern section featuring a combination of non-septic ponds and goosenecks. In the sub-villages of Luak Mani and Batu Tajam, the predominant practice involves the use of ponds and swan necks without septic tanks, as these areas are situated in the easternmost part of the UPTD Puskesmas Lunto Working Area.

IV. DISCUSSION

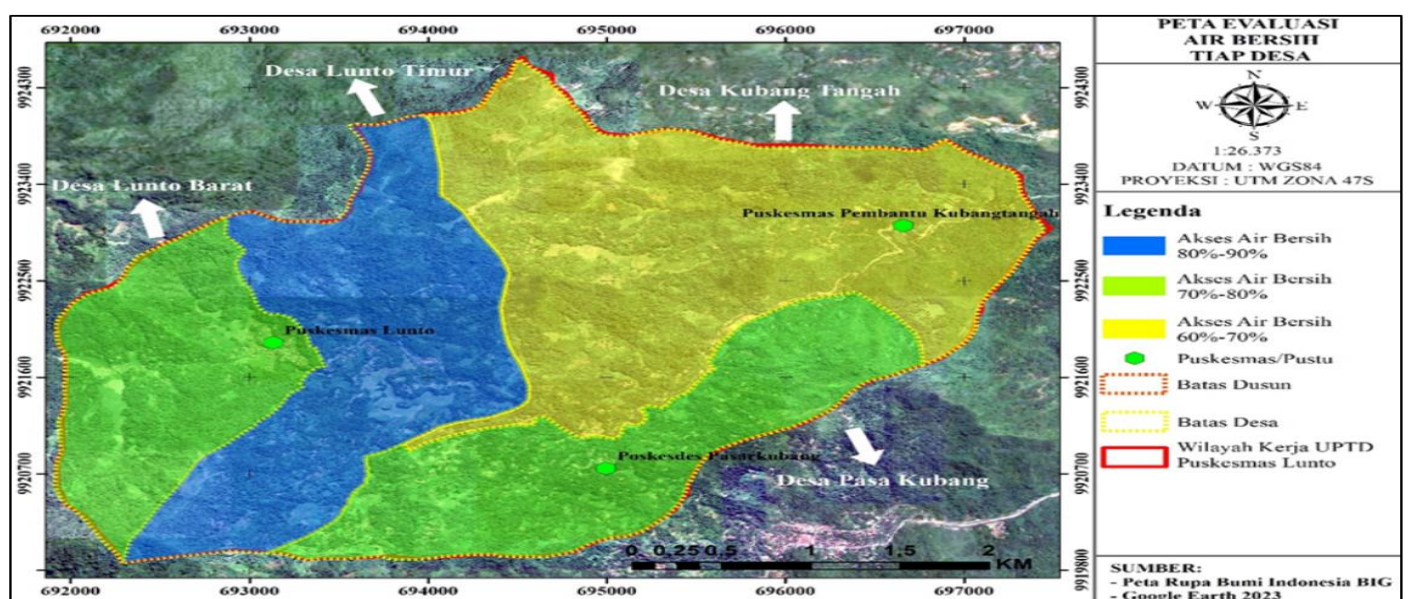A. *Evaluation of Access to Clean Water Facilities*

Fig 5 Clean Water Access Evaluation Map

Figure 5 illustrates the distribution of areas/polygons categorized by varying percentages of availability to clean water, specifically within the categories of 60%-70%, 70%-80%, and 80%-90%. East Lunto village exhibits the highest proportion of access to clean water amenities at 82.00% (shown in blue), whilst Kubang Tangah village demonstrates the lowest access at 61.24% (indicated in yellow). The settlements of West Lunto and Pasa Kubang exhibit comparable ranges, measuring 70.78% and 74.32%, respectively. The assessment of access to clean water involved comparing the quantity of households with clean water access to the total number of households within the administrative region. Table 5 illustrates the percentage of availability of clean water facilities for each hamlet.

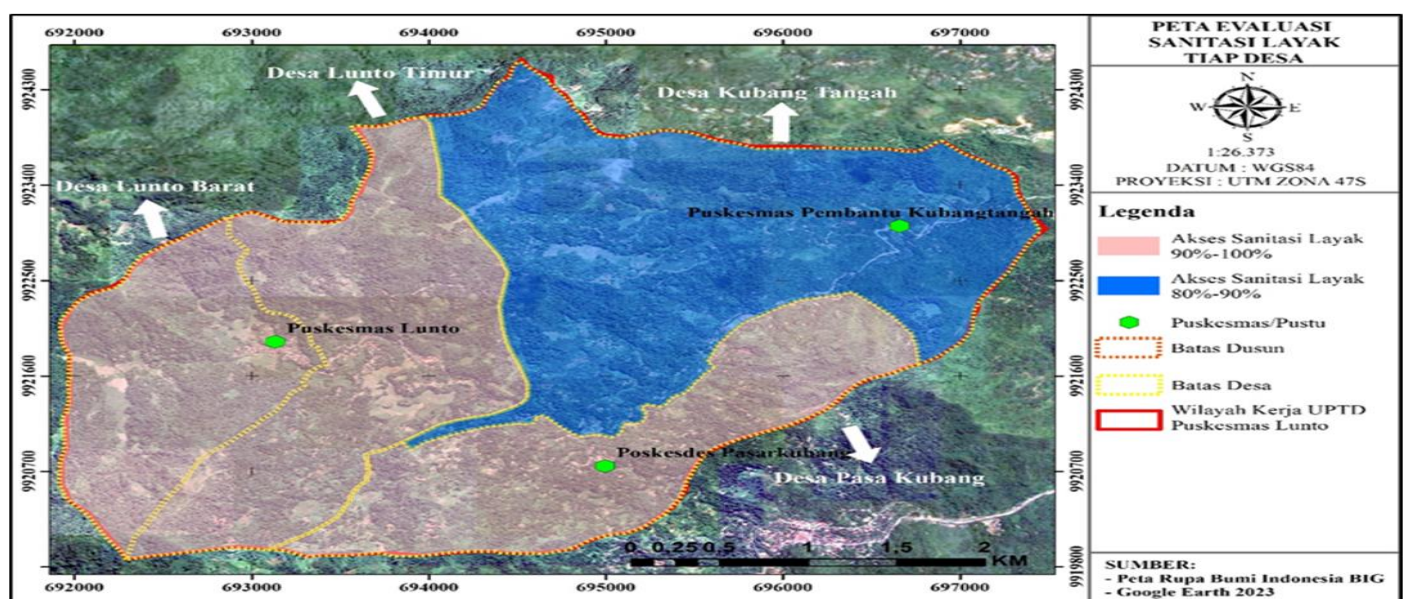*B. Evaluation of Proper Sanitation Ownership*

Fig 6 Evaluation Map of Proper Sanitation in Each Village

Figure 6 illustrates the distribution of areas/polygons exhibiting varying percentages of access to adequate sanitation, specifically within the ranges of 80%-90% and 90%-100%.Kubang Tangah Village has achieved a sanitation access rate of 88.95% (shown in blue). The distribution of regions exhibiting the highest percentage of improved sanitation correlates with the distance from UPTD Puskesmas Lunto, where West Lunto Village, the site of UPTD Puskesmas Lunto, demonstrates the highest percentage of access to improved sanitation. East Lunto Village is the nearest village to West Lunto Village. The correlation is more evident in Kubang Tangah village, the most distant village from the UPTD Puskesmas Lunto, which exhibits the lowest proportion of access to improved sanitation within the UPTD Puskesmas Lunto Working Area. Overall, the proportion of access to improved sanitation in each village within the study area exceeds the 70.97% access rate in West Sumatra Province (BPS West Sumatra Province 2020-2023), whereas Kubang Tangah Village's access rate is marginally lower than that of Sawahlunto City, which stands at 90.18%. This is also affected by the area's topography, geography, and the distribution of people settlements.

V. CONCLUSION

Mixed-method research analyzes primary and secondary data. In 2023, 1711 data on household heads' use of clean water sources and proper sanitation were collected from field mapping, RBI maps, and high-resolution Google Earth images for map making and spatial analysis using the overlay method. The study found that clean water and sanitation access varied by location. East Lunto village has the most clean water (82.00%), while Kubang Tangah has the least (61.24%). West Lunto village has the highest proportion of improved sanitation (96.40%), while Kubang Tangah village has the lowest (88.95%). Geographical conditions and population distribution in research locations affected clean water availability and access, resulting in water supply system integration issues. Poor sanitation pollutes and unprotects springs that may be pure water supplies. Based on the results of interviews with PDAM East Lunto administrators, the water discharge released from the processing tank is 20 cubic metres per second or equal to 20000 litres/second, if accumulated the water distributed can be 1,728,000,000 litres/day. This amount could meet the water needs of the entire community in the UPTD

Puskesmas Lunto working area of 4939 people, but given the geography and topography of the area this is difficult to meet. In the UPTD Puskesmas Lunto working area, there are still 115 families who do not have healthy latrines in their homes, the Sawahlunto City government urges its people not to defecate or hitchhike to the MCK and to family homes, and also from APBD-des funds to build family latrines since 2019, namely 5 units per year per village, and for the UPTD Puskesmas Lunto working area in early 2024 received assistance from the Ministry of Health as many as 30 units of healthy latrines.

ACKNOWLEDGEMENTS

REFERENCES

[1]. Kharistiani. AE dan E. Sistem Informasi Geografis Pemetaan Potensi Sma/Smk Berbasis Web Di Kabupaten Kebumen. Univ Ahmad Dahlan, Yogyakarta. 2013;

[2]. Sumantri A. Kesehatan Lingkungan. Jakarta:Kencana. 2015;

[3]. Adnani H. Ilmu Kesehatan Masyarakat. Nuha Med. 2011;

[4]. Dunia Butuh Air, Rencana Penanganan Risiko Corona Virus dengan Sanitasi. http://sda.pu.go id/bbwsserayuopak/dunia-butuh-airrencana-penanganan-resiko-corona-virusdengan-sanitasi/. 2020;

[5]. Sawahlunto PK. Surat Keputusan Walikota Sawahlunto Nomor.246 Tahun 2023. Sawahlunto; 2023.

[6]. PDAM. Sumber: data pemakai PDAM Kota Sawahlunto Tahun 2021. Sawahlunto; 2011.

[7]. Program P. Laporan Bulan Juli Surveilans dan Gizi UPTD Puskesmas Lunto Tahun 2023. Sawahlunto; 2023.

[8]. Kompas. Sustainable Transport, Sustainable Development. Cetakan 2. Sustainable Transport, Sustainable Development. Bandung: Unpad Press; 2021.

[9]. Kasaluhe MD. Sistem Informasi Geografi Untuk Pemetaan Cakupan Desa SBS (Stop Buang Air Besar Sembarangan) di Kabupaten Kepulauan Sangihe. Sains Dan Teknol. 2022;

[10]. Sadana. Kondisi lingkungan yang tidak higienis akan menyebabkan masalah pada kesehatan masyarakat. 2014;

[11]. Dr. Muhammad Ikhtiar, SKM MK. Pengantar Kesehatan Lingkungan. (SIGn) CSPG, editor. Makasar; 2017.

[12]. Fahrul Islam, Yoga Priastomo, Eni Mahawati NU, Indah Budiastutik, Miftah Chairani Hairuddin FF, Fajar Akbar, Windi Indah Fajar Ningsih RA, Dwi Septiawati, Askur EP. Dasar-Dasar Kesehatan Lingkungan. Rikki A, editor. Yayasan Kita Menulis; 2021.

[13]. Permenkes. Permenkes Nomor 13 Tahunn 2015 Tentang Penyelenggaraan Pelayanan Kesehatan Lingkungan Puskesmas. 2015;

[14]. Guru R. Manfaat SIG dalam Bidang Kesehatan Lingkungan. 2022;

[15]. RI DKLDKKK. Laporan Kinerja Kegiatan Kesehatan Lingkungan Tahun 2021. Jakarta; 2021.

[16]. IHC Telemed. Jumlah Konsumsi Air Putih Yang Baik Untuk Tubuh. Jakarta Selatan. 2021;

[17]. U. Wijaya Kusuma . Jurnal Ilmiah Kedokteran. Surabaya. 2010;

[18]. Mufidah. Syarat Sanitasi Layak. Purwokerto. 2017;

[19]. TaylorFrancis. Cartography/Visualization Of Geospasial Data. 2013;

[20]. Cromley dkk. GIS And Public Health. 2012;503.