ASERS

Journal of Environmental Management and Tourism

Quarterly
Volume XIV
Issue 1(65)
Spring 2023
ISSN 2068 – 7729
Journal DOI
https://doi.org/10.14505/jemt

ASERS Publishing

Spring 2023
Volume XIV
Issue 1(65)

ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt

Table of Contents:

1	**Methods of Combating Offenses in the Field of Ecology** Rostyslav SHCHOKIN, Vasyl OLIINYK, Oleksandr AMELIN, Yevhen BONDARENKO, Vitaliy MAZIYCHUK, Dmytro KYSLENKO	5
2	**The Use of Garden Plants - A Form of Balinese Local Wisdom in the Conservation** Anak Agung Ketut DARMADI, Ni Luh WATINIASIH, Anak Agung Gde Raka DALEM, Ni Made GARI	16
3	**The Extent of Considering Environmental Crimes as a Manifestation of Economic Crimes** Mohamad ALSHIBLE, Hamzeh ABU ISSA, Tareq AL-BILLEH	23
4	**Study of the Current State, Problems and Potential of the Waste Management System Affecting the Development of the Green Economy of the Region** Sergey BESPALYY, Yelena GRIDNEVA, Gulnar KALIAKPAROVA	32
5	**Participation in Household Hazardous Waste Management: A Case Study of the Dam Community, Northeast of Thailand** Sariya INTASIN, Nuchanart SRAKAT, Wachirakiat BAOTHONGCHAN, Suttiwan INTHAKANOG, Phajongjid PRATUMCHAD, Sasithorn PECHRSAN, Ananya POPRADIT	44
6	**"Green Products": A Review with the Consumer Buying Process Framework** Yanghui CAO	52
7	**Biofuel Production from Animal Waste in Northeastern of Libya: Experimental and Simulation Investigations** Monaem ELMNIFI, Abdelnaser OMRAN, Magdi ALMOSMARY, Rahel G. RAHEL	67
8	**Impact of State and Legal Regulation on the Sustainable Development of Agricultural Territories and Improving the Standard of Living of the Population** Pavel A. KALASHNIKOV, Arslan KULANOV, Erkin N. NESIPBEKOV, Assel KAISHATAYEVA, Shyryn M. KANTARBAYEVA	82
9	**The Extent of Constitutionalizing the Environmental Rights as One of the Anchors to Keep a Healthy, Clean Environment: A Difficult Balance between the International Agreements and the Jordanian Constitution's Restrictions** Ali AL-HAMMOURI, Tareq AL-BILLEH, Abdullah ALKHSEILAT	89
10	**Modeling Lasolo Watershed Sedimentation and Mangrove Root Growth at the Lasolo Coast in North Konawe, Indonesia** Nurul KHAKHIM, Farid YASIDI, Djati MARDIATNO, Agung KURNIAWAN	98
11	**Springs Distribution and Biophysical Mapping as a Strategy to Preserve Water Sources in Semarang City, Indonesia** Nana Kariada Tri MARTUTI, Dewi Liesnoor SETYOWATI, Margareta RAHAYUNINGSIH, Nur Kusuma DEWI, Wahid Akhsin Budi Nur SIDIQ, Dhita Prasisca MUTIATARI	113
12	**Improving the Environmentally Oriented Activities of Entrepreneurship** Aina AIDAROVA, Tazhikul MASHIROVA, Ainur ABILKASSYM, Aliya ATENOVA, Zhanna SHUGAIPOVA, Yerzhan ZHUSSUPOV	126
13	**Urban Ecosystem Network. Standardization's Effects upon Development of Green Open Spaces in the Arosuka River Flow Area** G. GUSMAL, Agus IRIANTO, Susi EVANITA	143
14	**Role of Microfinance in Mitigating Disasters in Pakistan** Hafiz Waqas KAMRAN, Abdelnaser OMRAN	150

Spring 2023
Volume XIV
Issue 1(65)

ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt

15	**Green Banking Tools for the Implementation of a State's Environmental Policy: Comparative Study** Bayanslu MARKHAYEVA, Alisher Serikbolovich IBRAYEV, Madina BEISENOVA, Gaukhar SERIKBAYEVA, Milton ARRIETA-LÓPEZ	160
16	**The Role of the Environment Committees in the Nineteenth Parliament for the Year 2020 in Studying Matters Related to Environmental Affairs in Jordan** Tareq AL-BILLEH, Hamzeh ABU ISSA	168
17	**Environmental Pollution Crime** Noor ALHENDI, Muamar SALAMEH	176
18	**Environmental and Socio-Economic Development Strategy of Depressed Regions** Dana AKISHEVA, Kanat ADILBAYEV, Zhibek ABYLKASSIMOVA, Aigul ADILBAYEVA, Zauresh NURGALIEVA	181
19	**Circular Economy in Ukraine on the Way to European Integration: Directions for Sustainable Management during the War and Post-War Recovery** Viktoriia SHVEDUN, Volodymyr BULBA, Liubov BOZHKO, Lesia KUCHER, Valentyna KHOLODOK, Oleksandr IHNATIEV	194
20	**Maintaining Environmental Sustainability through Public Financing. Insights from Kazakhstan** Anar KURMANALINA, Galiya TURMAKHANBETOVA, Zagira ISKAKOVA, Abzal MUKUSHEV, Nazgul KHAMITKHAN, Ruslana ICHSHANOVA	207
21	**Sustainable Development of Rural Areas in the Conditions of Globalization: Ukrainian Realities** Tetiana LISOVA, Svitlana SHARAPOVA, Viktoriia BREDIKHINA, Liudmyla LEIBA	217
22	**Climate Change Impacts and Environmental and Water use Behaviors, Beliefs and Perceptions** Ismail BANOO, Nirmala DORASAMY, Faizal BUX	225
23	**Overview of Projects Challenges to Achieve Transformations in Food Industry** Laura BAIZHANOVA, John CHRISTIANSEN, Duissekul KUNANBAEVA	236
24	**The Role of Press Tours in the Development of Park Recreation Complexes** Olesia DOLYNSKA, Ihor SMYRNOV, Inna SHOROBURA, Volodymyr MERCHANSKYI, Ihor TSURKAN	249
25	**Developing Nature Interpretation and Alternative Management Strategies to Promote Pro-Environmental Behaviors among Visitors to Thailand's National Parks** Pitoon AMORNWITTHAWAT, Noppawan Tanakanjana PHONGKHIEO, Thawan NIEAMSUP	261
26	**Ecotourism Routes in Ugam-Chatkal State Natural Park and Their Organization** Ulugbek NARMANOV, Otabek NARMANOV, Mirzaeva AZIZAKHAN	272
27	**The Amount of Tourist Waste in the Altai Mountains. Mongolia and Kazakhstan Cases** Badyelgajy YERBAKHYT, Bauyrzhan KAPSALYAMOV, Gulnur SASPUGAYEVA, Amarjargal MUNKH-ERDENE, Zhazgul TUSSUPOVA	283

Call for Papers
Summer 2023 Issues
Journal of Environmental Management and Tourism

Journal of Environmental Management and Tourism is an interdisciplinary research journal, aimed to publish articles and original research papers that should contribute to the development of both experimental and theoretical nature in the field of Environmental Management and Tourism Sciences.

Journal will publish original research and seeks to cover a wide range of topics regarding environmental management and engineering, environmental management and health, environmental chemistry, environmental protection technologies (water, air, soil), pollution reduction at source and waste minimization, energy and environment, modeling, simulation and optimization for environmental protection; environmental biotechnology, environmental education and sustainable development, environmental strategies and policies, etc. This topic may include the fields indicated above, but are not limited to these.

Authors are encouraged to submit high quality, original works that discuss the latest developments in environmental management research and application with the certain scope to share experiences and research findings and to stimulate more ideas and useful insights regarding current best-practices and future directions in environmental management.

Journal of Environmental Management and Tourism is indexed in SCOPUS, RePEc, CEEOL, and ProQuest.

All the papers will be first considered by the Editors for general relevance, originality and significance. If accepted for review, papers will then be subject to double blind peer review.

Deadline for submission:	21st April 2023
Expected publication date:	June 2023
Website:	https://journals.aserspublishing.eu/jemt
E-mail:	jemt@aserspublishing.eu

To prepare your paper for submission, please see full author guidelines in the following file: JEMT_Full_Paper_Template.docx, then send it via email at jemt@aserspublishing.eu.

Journal of Environmental Management and Tourism

DOI: https://doi.org/10.14505/jemt.14.1(65).11

Springs Distribution and Biophysical Mapping as a Strategy to Preserve Water Sources in Semarang City, Indonesia

Nana Kariada Tri MARTUTI
Biology Department, Faculty of Mathematics and Natural Science
Universitas Negeri Semarang, Indonesia
nanakariada@mail.unnes.ac.id

Dewi Liesnoor SETYOWATI
Geography Department, Faculty of Social Science
Universitas Negeri Semarang, Indonesia
liesnoor2015@mail.unnes.ac.id

Margareta RAHAYUNINGSIH
Biology Department, Faculty of Mathematics and Natural Science
Universitas Negeri Semarang, Indonesia
etak_sigid@mail.unnes.ac.id

Nur Kusuma DEWI
Biology Department, Faculty of Mathematics and Natural Science
Universitas Negeri Semarang, Indonesia
nur.kusuma.dewi@mail.unnes.ac.id

Wahid Akhsin Budi Nur SIDIQ
Geography Department, Faculty of Social Science
Universitas Negeri Semarang, Indonesia
akhsin1987@mail.unnes.ac.id

Dhita Prasisca MUTIATARI
Department of Community Empowermen
Yayasan Akar Banir Indonesia, Indonesia
dp.mutiatari@gmail.com

Suggested Citation:

Martuti, N.K.T. *et al.* (2023). Springs Distribution and Biophysical Mapping as a Strategy to Preserve Water Sources in Semarang City, Indonesia. *Journal of Environmental Management and Tourism*, (Volume XIV, Spring), 1(65): 113 - 125. DOI:10.14505/jemt.v14.1(65).11

Article's History:

Received 8th of November 2022; Received in revised form 2nd of December 2022; Accepted 5th of January 2023; Published 10th of March 2023.

Abstract

Springs in Semarang City, concentrated in Gunungpati District, are threatened by urbanization and massive development. It needs to be conserved through comprehensive strategies based on existing conditions. Therefore, this study aims to describe the distribution and biophysical conditions of the springs for water source conservation and sustainability. The study was conducted by identifying and mapping the biophysics condition and vegetation of 114 springs in Gunungpati District, Semarang City. The majority of the springs have low discharge volumes below 1 L/s, which is caused by ecosystem destruction around spring areas. Then, five springs were chosen for sampling, which have fairly good physics-chemical conditions and however polluted with E. coli and coliform bacteria from domestic and agricultural waste. Involving community-based conservation action through revegetating, building up water reservoir infrastructure, providing information boards, and enforcing spring protection culture can increase spring areas preservation. Furthermore, economic, social, and cultural studies on spring protection should be conducted to determine the protection zone priority, analyze the appropriate support system, and threaten potential in water sources sustainability.

Keywords: conservation; sustainability; water access; water supply.

JEL Classification: Q20; Q24; Q25.

Introduction

Semarang City consists of a narrow and densely populated coastal lowland, as well as a hilly area in the southern that extends from the west to the east side of the city. The hilly area is the upstream part of major rivers that provide spring points and is widely used by the community for daily water supply (Indrayati, Aji, and Hikmah 2018; Yulianto, Suripin, and Purnaweni 2019). The actual threat of springs and water sources in supporting clean water availability is increased land conversion and uncontrolled resident growth in green areas (Ram *et al.* 2022; Abbasi, Amirabadizadeh, Afshar and Yaghoobzadeh 2022). Even though, the green areas are designated as a water and resource conservation area (Wei *et al.* 2022). The most important area for conservation areas is located in Gunungpati District, the suburban area of the Semarang City, which is a highland. The rate of land change in Gunungpati is estimated more than 3% per year and reaches more than 4000 Ha in 2020 (Juhadi *et al.* 2021). Gunungpati District is a green area with abundant springs and a catchment area for three major rivers in Semarang City. Thus, the land change increases the risk of erosion, landslides, and floods so that the impact on the availability of surface springs and groundwater (Juhadi, Pratiwi, Trihatmoko and Trihatmoko 2020; Nugraha, Firdaus and Sasmito 2018). Therefore, this study aims to map the biophysical conditions of the spring area in Semarang City as consideration for sustainable area management. In addition, the potential of springs can be utilized as an effort to mitigate climate facing the risk of drought due to climate change.

1. Literature Review

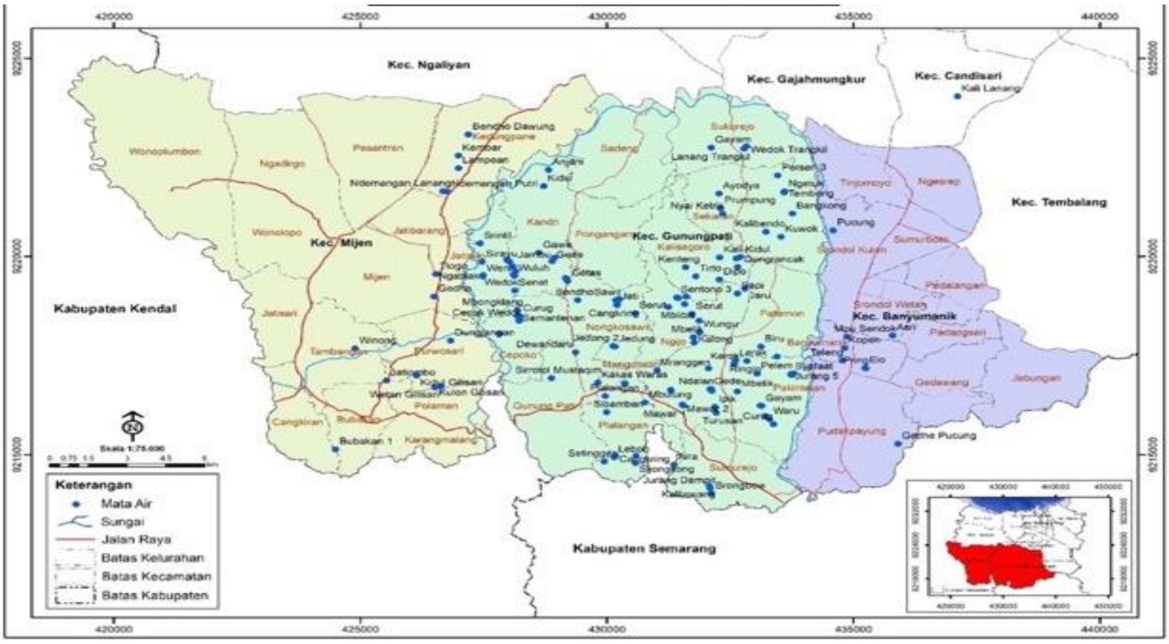
The Semarang City, which is the fifth largest metropolitan city in Indonesia, is one of the attractive destinations for the development of industrial and residential areas (Ridlo and Ghiffari 2022). It then increases land use changes in sub-urban areas for industrial development and infrastructure provision. The rate of population growth is also assumed as one of the main contributors in increasing settlements in the last 10 years in the sub-urban area, especially in Gunungpati District (Hardati and Setyowati 2019).

There are at least more than 139 springs identified in the upper Semarang City, widely spread in the three sub-urban areas, namely Mijen, Gunungpati, and Banyumanik Sub-districts. Several springs in those areas are managed independently as a supply of clean water (Martuti, Rahayuningsih and Sidiq 2021). In addition, as many as 107 springs are used for irrigation purposes of agriculture covering an area of 3,793 Ha. Several efforts for preserving water sources can be conducted through habitat conservation around springs that involves community to emerge sense of belonging of the clean water availability and access (Rakatama and Pandit 2022; Pambudi 2021). In addition, the spring preservation may also prevent the declining trend of ecosystem quality that caused fragmentation and increased population. The determination of the status and boundaries of spring protection zones requires an approach through a holistic assessment of vulnerability, aquifer nature, and preferential infiltration zones. This can be started by identifying the biophysical characteristics of the catchment area and the hydrological characteristics of the spring (Supangat, Purwanto, Hendrayana, and Riyanto 2022; Daryono *et al.* 2019). Based on those essential role and benefit, the preservation of springs in Gunungpati District, Semarang City needs to be done to maintain water sustainability to increase resilience to climate change, which has an impact on water supply and delivery.

2. Methodology

This research was an observational study of spring exploration to obtain information on spatial distribution and biophysical conditions to conserve water resources in Semarang City, Indonesia. The distribution of the main springs in Semarang City were located in Mijen, Gunungpati, and Banyumanik Districts. The sampling areas and data collection were carried out in Gunungpati District because it has the most abundance springs that utilized for domestic and agricultural needs (Figure 1).

Figure 1. Research location. The spring population area includes Mijen (yellow) and Banyumanik (purple) sub-districts, sampling site Guungpati district (green)



Data were collected through surveys, field observations, and in-depth interviews with the communities around the springs. Field survey activities are used to obtain information related to spring conditions, discharge measurements, physical quality measurements, and factors affecting spring conditions. Water discharge and physical quality was carried out in filed actual measurement using a Current Meter device, while vegetation data was collected through direct field-observation and exploration by counting and identifying the three species. Interview activities were conducted to obtain information related to the use of springs and conservation actions carried out by residents in efforts to conserve these water resources.

Table 1. Environmental aspects in the assessment

Environmental aspects	Score		
	3 (high)	2 (moderate)	1 (low)
Land Use Conditions	Forest / Moor	Rice Fields / Agriculture	Settlements/ Industries
Plant type conditions	Healthy, there are types of spring plants (mahogany, jackfruit, breadfruit, ficus, etc.) and there are types of water filter plants (bamboo, husk, etc.)	Weathered and hollow, there are types of water filter plants (bamboo, husk, etc.)	No spring support plants
Water discharge	Large (1,000 - 10,000 L/s)	Medium (1 - 999 L/sec)	Small (< 1 L/sec)
Spring protection efforts	There are Spring Signages, Reservoirs, Rules (prohibitions)	There is no name and or there is a shelter or vice versa	No protection efforts
Water Quality	The color of the water is clear, odorless	The color of the water is clear and or smelly, or vice versa	The color of the water is turbid and smelly

Note: the developed criteria were adapted and modified from Fathi, *et al.* (2018)

Preparation of spring protection zones

The determination of spring protection zones in each region was conducted by compiling various data including physiochemical, biological data vegetation to determine the quality and recommendations for utilization in each spring. The recommendation of protected areas for preserving the spring was determined from the quality of the environment around the springs. The protection zone was expressed in a radius based on the natural level of vegetation, flow of water sources, and potential contamination (Nugroho, Soemarno, Riniwati and Afandhi 2019; Al-Manmi and Saleh 2019).

Data Analysis

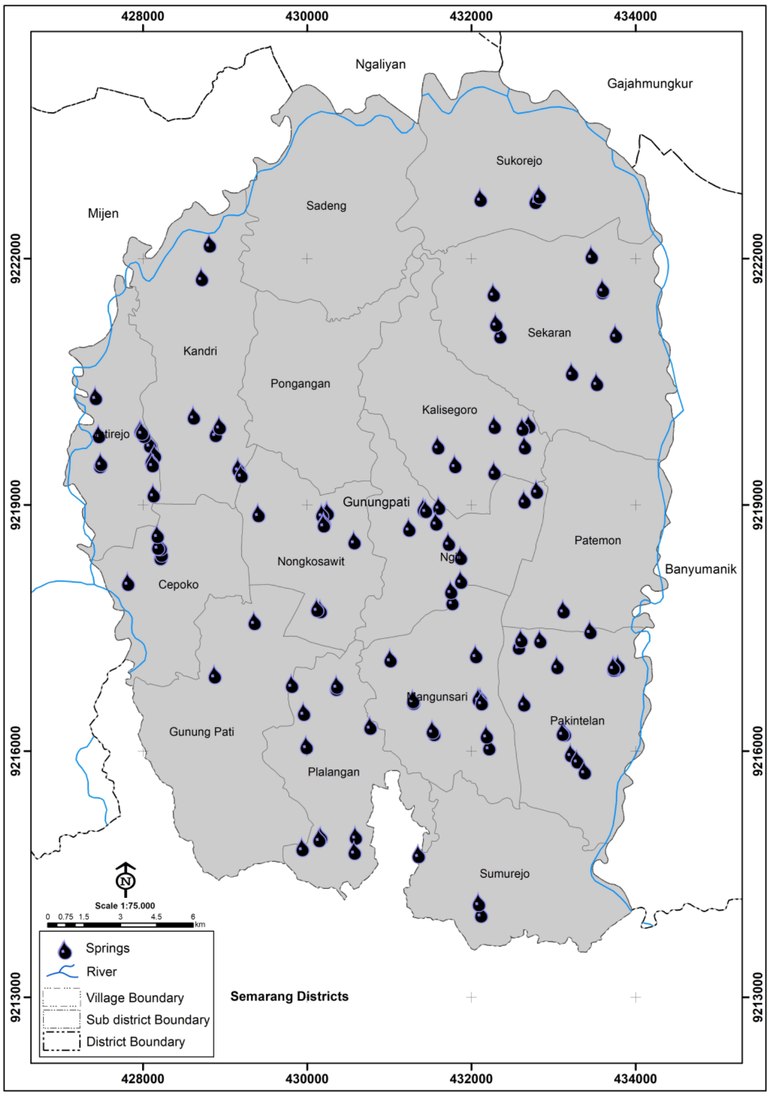
The data analysis method in this study uses spatial, hydrological, and qualitative analysis, where spatial analysis was used to describe the spatial distribution of spring sources which is realized in the form of a thematic map. Meanwhile, hydrological analysis is used to identify the quality of water production (discharge) from each spring and analyze the quality of springs in several locations. Furthermore, qualitative analysis through local wisdom of the community in efforts to conserve water resources at the research site.

3. Case Studies

Spring Sites Environment Characteristics

Based on the results of surveys and observations, at least 114 spring points were found in Gunungpati District spread across 13 urban villages which were then visualized in the form of spatial distribution maps (Figure 2-4). The distribution of spring water is on average in high areas with a height of ≥ 250 m.a.s.l, not on the territory of the basin and far from the slopes. The data only records the number of springs used for agricultural irrigation activities, so it is estimated that there are still many springs that have not been identified. The influence of geological structures in Semarang City is in the form of erosive soil faults with high porosity, discontinuous rock layers, and heterogeneous, so that they are easy to move or landslides. Hydrogeological, fracturing, and discontinuity fields form the aquifer to allow seepage and deposition of water which is an important aspect and has the potential to give rise to springs (Devy 2018; Baechler, Cross and Baechler 2019).

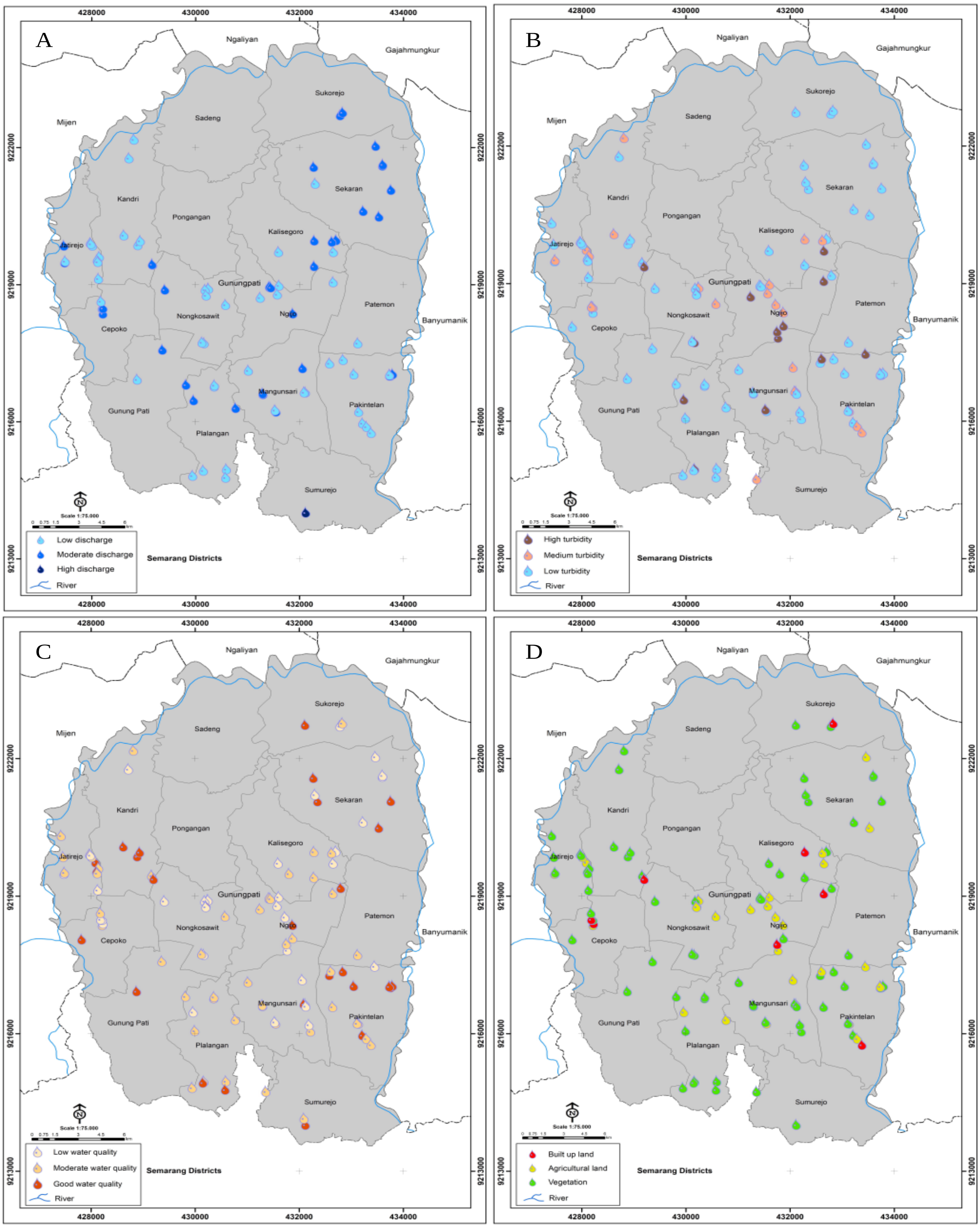
Figure 2. Spatial distribution of water spring in Gunungpati Sub-district



Sub-District	Spring
Cepoko	7
Gunungpati	2
Jatirejo	12
Kalisegoro	7
Kandri	8
Mangunsari	11
Ngijo	13
Nongkosawit	10
Pakintelan	16
Patemon	1
Plalangan	11
Sekaran	9
Sumurejo	7
Total	114

In general, the majority of each spring is observed to have a low-moderate discharge about 49% of the springs have a water discharge of less than 1 liter /second. In addition, about 25% of the 114 springs in Gunungpati District are unknown discharge generated because they do not have a water outlet. This is because the shrinkage of water volume is caused by seepage due to cracked rocks at the bottom of the reservoir. Most of the spool tubs are also at the bottom so they cannot be concentrated using hoses and measuring buckets. Furthermore, according to quality, around 62% or as many as 71 springs have medium quality-both used for drinking water purposes and domestic water needs. While the rest have poor quality such as water polluted with household waste, detergents, and turbidity.

Figure 3. Ecological condition of the water spring in Gunungpati. A) water debit; B) turbidity; C) water quality, and; D) surrounding ecosystem.



The results of the observations showed that the decrease in the discharge and quality of springs was due to changes in ecosystems and vegetation due to anthropogenic factors. Increased population migration and massive housing development in buffer areas have the potential to cause spring loss (Weinthal, Zawahri and Sowers 2015). One of the factors is the increase in development in buffer areas, due to increasing population growth and population migration from coastal areas due to abrasion and climate change (Buchori *et al.* 2018). The increase in housing has an impact on increasing the production of domestic waste, detergents, and plastics in the spring area (Widodo, Budiastuti and Komariah 2019 Marleni and Raspati 2020). In addition, agriculture has the potential to contribute to chemical fertilizer contamination and cause blooming algae so that the water becomes green and causes odors (Marleni and Raspati 2020 Lubada, Yokota, Hartono and Miyaura 2018).

The condition of the spring creates adaptive behavior in the community with a utilization model by the quality of the spring. Spring water with medium-low quality is more widely used for agricultural irrigation purposes bathing and washing, along with the entry of regional drinking water companies in the region. Meanwhile, spring water of good quality is used by building a reservoir made independently by the community or by the village government to precipitate dirt, filter leaves, and prevent plastic contamination. The tub is made with a foundation of various shapes, depths, and sizes, where most of the spools have a depth of about 1-50 cm and 51–100 cm, to facilitate management and maintenance. In addition, the existence of a reservoir also serves to facilitate the use of water through a management system to provide access to clean water that is distributed using pipes or taken manually using jerry cans and buckets. The clean water management system is provided by village officials with monthly dues for the maintenance of water sources and distribution instruments. This is a form of community independence in managing springs so that they remain sustainable and are utilized sustainably.

Characteristics and Quality of Springs

Public awareness about the importance of clean water sources has begun to take shape by protecting springs through physical development to socio-cultural values. Interesting findings in the field also show that springs that are used as clean water, are treated sacredly to preserve the ecosystem, are managed in cooperation according to an agreed schedule, and the procurement of special customary ceremonies to care for springs. The maintenance of these springs is one of the vital activities and characteristics of suburban communities as a learning process about the importance of clean water sources. Considering, that every spring can be used on average by around 40 households (in one neighborhood area), some springs can be used by residents in one hamlet (consisting of 100 households).

Based on the identification results, at least 22 springs are prioritized to supply clean water for community use that is physically protected using concrete reservoirs and local wisdom that spreads across 11 urban villages. Furthermore, this study also identified five springs with high discharge, high utilization, and good quality but poorly maintained as a special study to see the condition of the water quality produced. The springs include Jedung, Nongkosawit village; Trangkil, Sukorejo; Dungrancak, Kalisegoro; Mbiru, Patemon; and Gede, Kandri (Figure 4). Then, the five springs were used as samples for the profiling of stand vegetation. The identification results showed that the most common vegetation stands found were Swietenia mahagoni and Musa paradisiaca, while springs with vegetation were best found in Dungrancak, Kalisegoro Village (Table 2).

The abundance of water with a large discharge is found in almost all springs with a lush level of upright vegetation, mainly due to the presence of woody plants with deep roots such as Ficus and Artocarpus. The existence of Ficus and Artocarpus is the dominant species located around springs and correlated with the quality and sustainability of water sources (Siswo, Yun and Abdiyani 2019). The root system of Ficus and Artocarpus helps in forming the aquifer layer (Fiqa and Darmayanti 2018), preventing erosion as well as water (Fathoni, Rohman and Sulisetijono 2021), and maintaining the physical structure of the springs so that no damage occurs and closes the seepage of water sources (Siswo, Yun and Abdiyani 2019). In addition, the existence of large stands in water sources is often sacred by the community intending to maintain the preservation of springs (Batoro, Hakim and Rahardi 2020). This shows that the revegetation of tree stands in the spring affix area and around the spring can function as a protection for the spring both in terms of ecological, and socio-cultural.

To obtain information on hydrological conditions, physical conditions, and utilization of the spring, measurements and observations were carried out in the field on several parameters to determine the water quality, utilization, and consistency of the spring.

Table 2. Vegetation stands in the springs of the sample location.

Family	Species	Jedung	Trangkil	Dungrancak	Mbiru	Gede
Anacardiaceae	*Dracontomelon mangiferum*					v
	Mangifera indica			v		
Araceae	*Arenga pinnata*			v		v
	Cocos nucifera			v	v	v
Caricaceae	*Carica papaya*			v		
Clusiaceae	*Garcinia mangostana*				v	
Fabaceae	*Albizia chinensis*		v		v	
	Parkia speciosa			v		
	Pterocarpus indicus			v		
Malvaceae	*Durio zibethinus*				v	
	Hibiscus tiliaceus			v		
Meliaceae	*Swietenia mahagoni*		v	v		v
Moraceae	*Artocarpus communis*		v	v		
	Artocarpus elastica					v
	Ficus benjamina	v			v	v
	Ficus callosa		v			
	Ficus hispida		v			
Musaceae	*Musa paradisiaca*	v		v	v	
Mytaceae	*Syzygium sp*				v	
Poaceae	*Bambusa sp*				v	
Sapindaceae	*Nephelium lappaceum*			v	v	

Some of the parameters that were measured in the field included: water electrical conductivity, turbidity, dissolved oxygen (DO), Escherichia coli, and Total Coliform contained in the springs of each research site. From the results of research in the field obtained the results of spring water quality in Gunungpati are as follows (Table 3):

Table 3. Chemical, biological, and utilization characteristics in five spring samples

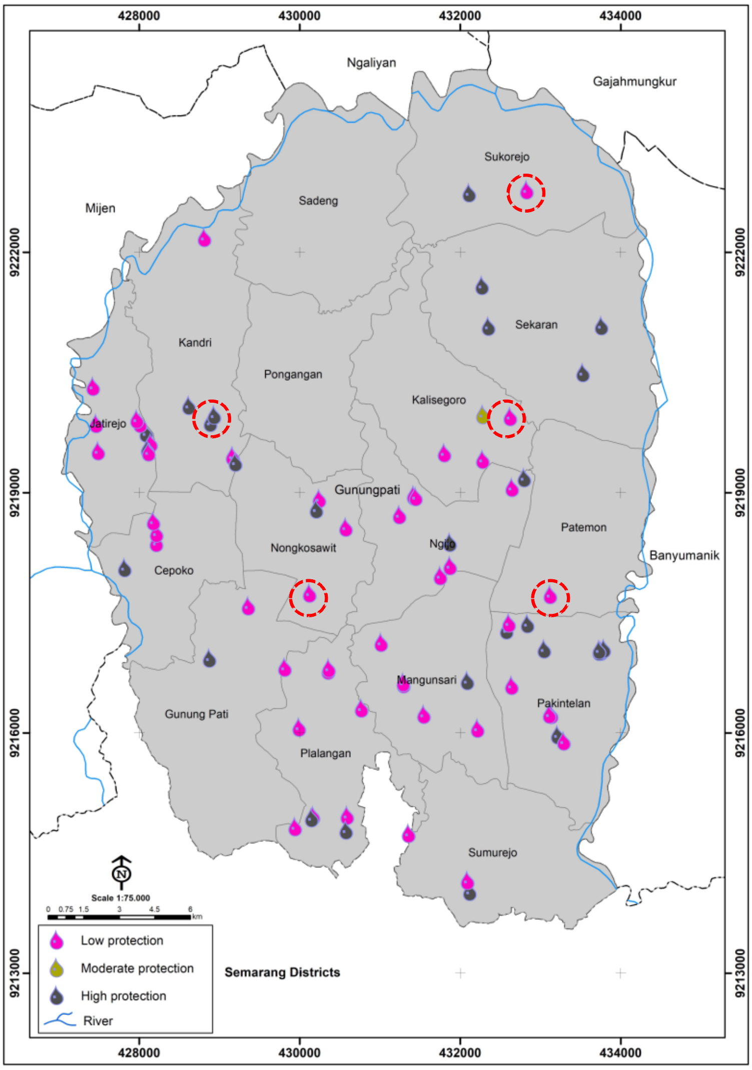
Parameters	Test Results					Standards Quality
	Jedung	Trangkil	Dungrancak	Mbiru	Gede	
Electrical conductivity (µS/cm)	160.00	547.00	274.00	166.00	209.00	12,500.00*
Turbidity (NTU)	8.93	0.70	7.66	4.14	2.10	25.00**
Dissolved oxygen (DO) (mg/l)	7.38	7.00	9.21	8.07	7.61	4.00***
E. coli (cells/100 ml)	300.00	2,100.00	1,500.00	400.00	2,400.00	1,000.00
Total coliform (cells/100 ml)	6,700.00	9,500.00	5,800.00	8,600.00	5,500.00	5,000.00
Utilization						
Water Drinking	++	+++	+++	+	+	
Washing/ bathing	++++	++++	++++	++++	++++	
Irrigation (Agriculture)	++++	-	-	++++	+++	

Note: *) Regulation of the Minister of Health of the Republic of Indonesia Number 492 / MENKES / PER / IV / 2010 concerning drinking water quality requirements, referred to as drinking water is water that meets health requirements that can be drunk immediately;
**) Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for Sanitary Hygiene Purposes, Swimming Pools, Solus Per Aqua, and Public Baths.
***) Government Regulation Number 22 of 2021 concerning the Implementation of Protection and Management I.

Measurements of the environmental aspects of the sample springs in five urban villages showed that overall, the samples had adequate physical-chemical characteristics to be used as a source of clean water. The results of measuring water electrical conductivity values in Springs in 5 springs in Gunungpati range from 160 – 547 rµS/cm (Table 3). This electrical conductivity value is well below the maximum electrical conductivity water threshold for sanitary hygiene. Electrical conductivity is the number that expresses the ability of a liquid solution to conduct electric current. This ability depends on the presence of inorganic ions, such as OH^-, H^+, SO_4^{2-}, Na^+, and PO43 + (Fathi, Zamani-Ahmadmahmoodi and Zare-Bidaki 2018; Zinabu, Chapman and Chapman 2002). In addition, the presence of essential mineral ions such as Na^+ and Mg^{2+} as well as heavy metals, such as Cd^{2+} and Cu^{2+} also contributes to an increase in electrical conductivity values (Erebho 2022).

Whereas physically, the value of the electrical activity of inorganic ions (μS/cm) is also influenced by the total concentration of ions, the valence of the relative concentration of ions, and the temperature at the time of measurement. Electrical conductivity needs to be known to indicate the concentration of mineral solutions in water. For example, river water has a conductivity of between 10 to 1,000 μS/cm (Zinabu, Chapman and Chapman 2002). The high content of inorganic ions causes higher conductivity causing water to feel brackish to salty. The large value of electrical conductivity indicates the many types of organic matter and minerals that enter waste into the waters (Rusydi 2018).

Figure 4. Water springs distribution based on protected status. The sampling sites are marked in the red circle.



The presence of inorganic ions is not related to the level of turbidity of the water but is determined by dissolved organic particles and sludge (Stevenson and Bravo 2019). Thus, the more dissolved organic matter and mud, the more turbidity will increase. The results of research on the quality of springs in Gunungpati showed that the turbidity of springs ranged from 0.7 – 8.93 NTU, far below the threshold set by the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017, amounting to 25 NTU. This shows the low contamination of organic materials such as food or agricultural waste which causes blooming algae. Furthermore, water turbidity also has an impact on reducing dissolved oxygen (DO) levels due to the low rate of photosynthesis (Sila 2019).

The quality of the spring water is good and clear, also supported by the high do levels at the sampling location, where the results of the do levels range from 7-9.21 mg / L or higher than the predetermined quality standards. The results show that the environmental conditions around the springs are still safe from contamination and need to be preserved. Oxygen plays an important role as an indicator of water quality because it plays a role in the oxidation and reduction process of organic and inorganic matter which has an impact on the feasibility of spring consumption (Duressa, Assefa and Jida 2019). Physical and chemical qualities that indicate the feasibility of spring water as a source of clean water and sanitary hygiene, are not supported by biological conditions. Based on laboratory tests, there are indications of E coli contamination in three springs, namely Trangkil, Dungrancak, and Gede, with concentrations reaching more than 1000 cells/ 100 ml and coliform bacteria above the quality standard (≥ 5000 cells/ 100 ml) at all sampling sites. This condition needs to be the focus of spring managers to improve the safety and health of clean water, considering that the spring is a source of clean water and sanitation for the community (Sila 2019 Duressa, Assefa and Jida 2019).

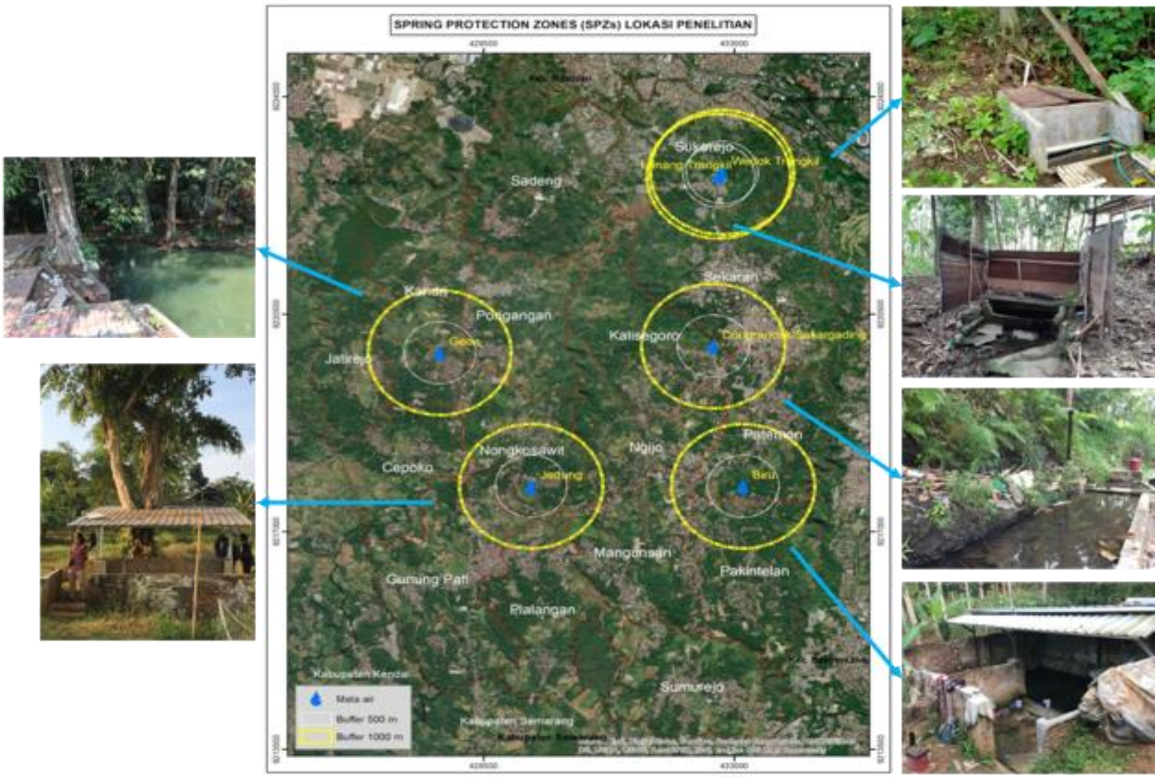
Interesting facts found in the field show that although the ecosystem and spring vegetation are still in good condition, there is still leakage of contamination of pathogenic organisms likely from the domestic activities of the community around the spring. In addition, the location of the spring is adjacent to an agricultural area that uses animal manure as organic fertilizer, so the remaining fertilizer and agricultural waste may be carried to the water source (Sari *et al.* 2018). This is relevant to other studies that show that coliform bacteria can be sourced from organic waste, agricultural runoff, to fecal contamination (Indrastuti, Kazama and Takizawa 2021; Onyango, Okoth, Kunyanga and Aliwa 2018; Agensi *et al.* 2019). Meanwhile, the presence of fecal coliform bacteria in the source of consumption water can cause an increased risk of infectious diseases in the gastrointestinal tract.

Strategies and Efforts to Establish Spring Protection Zones (SPZs)

Spring Protection Zones (SPZs) are arranged to identify areas of protection for the sustainability and consistency of springs, focused on five sample springs. Determination of SPZ based on vegetation conditions and water quality is a form of effort that can be made to save and protect springs. In this study, recommendations compiled based on vegetation profiles and threats to water quality led to the formation of three protection zones (Figure 5).

Protection Zone I is a protected area that aims to protect water from all pollutants that directly or indirectly cause degradation of water quality, with a radius determined as far as 10 – 15 meters from the spring. The determination of the Protection zone I specifically does not require technical research, thus it can be directly measured in the field. While the Protection Zone II is a protected area that aims to protect clean water of the spring from the danger of pathogen bacterial pollution that can cause degradation of water quality, with an area calculated based on the distance traveled by coliform bacteria for 50 days to the spring area (Al-Manmi, and Saleh 2019).

Figure 5. The current and recommendation for spring protection zone. The white dash line represents the 1st protection zone and the yellow dash line for the 2nd protection zone.



Based on the map, it can be described that the protection zones in each spring are in the type of land use, vegetation area, built-up land, and open land. So that the protection in each of these zones can be applied optimally, considering that built-up land is a relatively high threat to the consistency of springs and that zone has a fairly large area. Natural protection efforts are carried out by preserving vegetation around springs that function as an infiltration medium to increase the potential of deep groundwater, especially bamboo-type vegetation that can purify water to increase the quantity of groundwater. Furthermore, the city government through local regulations also needs to regulate the creation of drill life around the springs to reduce groundwater exploitation. This massive use of groundwater has an impact on land subsidence and the availability of surface water (Rahdriawan *et al.* 2021). In addition, infrastructure development in the form of reservoirs, signage, and regulations to maintain springs needs to be carried out to ensure the quality and sustainability of water sources for the community. Furthermore, efforts to conserve springs in an integrated manner need to be communicated and coordinated to the community intensely, thereby increasing self-belonging to the springs they use (Hermanto and Nugroho 2021).

Furthermore, spring protection is carried out by establishing socio-culturally activity, especially traditional ceremony. For example, the community in study site forms an devotional work to clean the springs called Nyadran (a traditional ceremony and ritual to clean up the spring). The ceremony activity includes draining the springs to clean the sediment in the reservoir and clearing grass and weeds that interfere with the flow of water. Maintenance and management activities to maintain the cleanliness and preservation of springs are mostly carried out by the community incidentally, while Nyadran is carried out at certain times (Javanese Calendar), which is carried out from Sidodadi spring to Gede spring (Kandri Village) in the early rainy season. The spring care activities cannot be separated from the values of local wisdom of the community to maintain the existence and sustainability of the spring. Community participation is very important to maintain the existence and sustainability of springs (Tantoh and Simatele 2018). In principle, community participation in the preservation of springs can take place if the community has an understanding and awareness of the benefits of the existence of the spring which are influenced by social, economic, environmental, and cultural conditions. Where the values of local wisdom are passed down for generations through informal education, family, and community.

Conclusion

The majority of springs in Gunungpati District, Semarang City have a water discharge less then 1 L/s with fairly good physicochemical conditions but indicated high contamination of E. coli and coliform bacteria from domestic and agricultural waste. Although, more than 62% of the total 114 springs are used for domestic clean water purposes including cooking, bathing, and washing, as well as irrigation. In addition, vegetation conditions in some spring samples also degraded which resulted in a decrease in water discharge. Thus, efforts to conserve springs are carried out by preserving vegetation around the springs, in addition to that, spring protection is carried out by developing infrastructure, most of which are in the form of water reservoirs, giving and installing spring signage and prohibition regulations, enforcing regulations for the protection of water source areas, and increasing direct community involvement. This research focuses only on the physical, chemical, and biological conditions of water quality to determine the priority of the protection zone. Therefore, future research is expected to be able to identify and assess social, cultural, and economic factors that have the potential to threaten and support the sustainability of water sources in Gunungpati District.

Acknowledgments

The researcher's gratitude is conveyed to the Directorate of Research and Community Service (DRPM), the Ministry of Education and Culture of the Republic of Indonesia for funding this research through the Higher Education Excellence Basic Research scheme, grant number: 37.11.5/UN37/PPK.6.8/2022, as well as the Institute for Research and Community Service, Semarang State University which has facilitated the achievement of this research.

Reference

[1] Abbasi, A., Amirabadizadeh, M., Afshar, A.A., and Yaghoobzadeh, M. 2022 Potential influence of climate and land-use changes on green water security in a semi-arid catchment. *Journal of Water and Climate Change*, 13(1): 287–303. DOI: https://doi.org/10.2166/wcc.2021.055

[2] Agensi, A., *et al.* 2019. Contamination potentials of household water handling and storage practices in Kirundo Subcounty, Kisoro District, Uganda. *Journal of Environmental and Public Health*, 2019: 7932193. DOI: https://doi.org/10.1155/2019/7932193

[3] Al-Manmi, D.A.M.A., and Saleh, K.A. 2019. Delineation of spring protection zone and vulnerability mapping of selected springs in Sulaymaniyah area, Kurdistan. *Iraqi National Journal of Earth Science*, 78(21): 1–16. DOI: https://doi.org/10.1007/s12665-019-8632-2

[4] Baechler, F.E., Cross, H.J., and Baechler, L. 2019. The geology and hydrogeology of springs on Cape Breton Island, Nova Scotia, Canada: An overview. *Atlantic Geology*, 55: 137–161. DOI:https:///doi.org10.4138/atlgeol.2019.004

[5] Batoro, J., Hakim, L., and Rahardi, B. 2020. The perception of sacred trees as proponent of water spring in Malang Regency East Java, Indonesia. *Asian Journal of Medical and Biological Research*, 6(3): 425–430. DOI: https://doi.org/10.3329/ajmbr.v6i3.49790

[6] Buchori, I. *et al.* 2018. Adaptation to coastal flooding and inundation: Mitigations and migration pattern in Semarang City, Indonesia. *Ocean & Coastal Management*, 163(8): 445–455. DOI:https://doi.org/10.1016/j.ocecoaman.2018.07.017

[7] Daryono, L.R., *et al.* 2019. Geological spatial plan toward groundwater resources in Kertek, Wonosobo Basin, Central Java, Indonesia. *Journal of Degradation and Mining Lands Management*, 6(2): 1595–1608. DOI: https://doi.org/10.15243/jdmlm

[8] Devy, S.D. 2018. Hydrogeology of Karang Mumus watershed in Samarinda, East Kalimantan Province, Indonesia. *Forum Geografi*, 32(1): 12–23. DOI: https://doi.org/10.23917/forgeo.v32i1.5229

[9] Duressa, G., Assefa, F., and Jida, M. 2019. Assessment of Bacteriological and physicochemical quality of drinking water from source to household tap connection in Nekemte, Oromia, Ethiopia. *Journal of Environmental and Public Health*. DOI: https://doi.org/10.1155/2019/2129792

[10] Erebho, U.I. 2022. Relationship between electrical conductivity and some mineral composition of Benin Rivers. *Pakistan Journal of Scientific and Industrial Research Series A: Physical Sciences*, 65A(2): 104–111. Available at: https://www.v3.pjsir.org/index.php/physical-sciences/article/download/477/312

[11] Fathi, E., Zamani-Ahmadmahmoodi, R., and Zare-Bidaki, R. 2018. Water quality evaluation using water quality index and multivariate methods, Beheshtabad River, Iran. *Appl Water Sci.*, 8(7): 1–6. DOI:https://doi.org/10.1007/s13201-018-0859-7

[12] Fathoni, A., Rohman, F., and Sulisetijono, S. 2021. Comprehensive characterization of tree vegetation around various springs in Malang region, East Java, Indonesia. AIP Conference Proceedings, 2353: 030114. DOI: https://doi.org/10.1063/5.0052983

[13] Fiqa, A.P., and Darmayanti, A.S. 2018. Floristic and soil characteristic at the RPH Sentul-Probolinggo protected low land forest, East Java. *Journal of Tropical Biodiversity and Biotechnology*, 3(1): 18–25. DOI:https://doi.org/10.22146/jtbb.30208

[14] Hardati, P., and Setyowati, D.L., Population growth in the upper garang watershed Semarang Regency, Central Java Province, Indonesia. *IOP Conference Series on Earth and Environmental Science*, 256(1). DOI:https://doi.org/10.1088/1755-1315/256/1/012032

[15] Hermanto, Y.B., and Nugroho, M. 2021. Communicating the springs and forest preservation in the Arjuna mount area. Indonesia. *Indonesian Journal of Communications Studies*, 5(2): 379–396. DOI:https://doi.org/10.25139/jsk.v5i2.3785

[16] Indrastuti, S. Kazama, and S. Takizawa. 2021. Evaluation of microbial contamination of groundwater under different topographic conditions and household water treatment systems in special region of Yogyakarta province, Indonesia. *Water*, 13(12): 1673. DOI: https://doi.org/10.3390/w13121673

[17] Indrayati, A., Aji, A., and Hikmah, N. 2018. 3D model and morphometry of the Beringin watershed as an effort for flash flood disaster risk reduction in Semarang, MATEC Web of Conferences. 229, 2018, DOI:https://doi.org/10.1051/matecconf/201822904010

[18] Juhadi, J. Pratiwi, E., Trihatmoko, E., and Trihatmoko, N. 2020. Multy-stressor Analysis of Sociocultural Condition: A Study on Land Degradation in Kreo Watershed, Semarang City, in International Conference of Environmental and Sustainability, June 2020. DOI: https://doi.org/10.4108/eai.18-7-2019.2290307

[19] Juhadi, J. *et al.* 2021. Rural–urban transformation and landuse dynamics in gunungpati on the northern flank of Mt. Ungaran, Semarang, Indonesia. *Indonesian Journal of Geography*, 53(2): 170–178. DOI:https://doi.org/10.22146/ijg.52385

[20] Lubada, L.A., Yokota, K., Hartono, A., and Miyaura, R. 2018. Effects of agriculture on the water quality of the Cisadane River system in West Java, Indonesia. *Tropical Agriculture and Development*, 62(2): 94–103. DOI:https://doi.org/10.11248/jsta.62.94

[21] Marleni, N.N.N., and Raspati, G.S. 2020. A critical review of wastewater resource recovery implementation in Indonesia. *Journal of the Civil Engineering Forum*, 6(1): 89–102. DOI: https://doi.org/10.22146/jcef.52755

[22] Martuti, N.K.T., Rahayuningsih, M., and Sidiq, W.A.B.N. 2021. Kajian pemetaan potensi mata air di Kota Semarang [the study of mapping the potential of springs in the Semarang City]. *Jurnal Riptek*, 15(2): 1–7. Available at: https://riptek.semarangkota.go.id/index.php/riptek/article/view/130

[23] Nugraha, A.L., Firdaus, H.S., and Sasmito, B. 2018. Erosion risk modelling using geographic information system in Beringin Watershed, Semarang City. In The 4th International Symposium on Geoinformatics, pp. 1–6. DOI: https://doi.org/10.1109/ISYG.2018.8611949

[24] Nugroho, M., Soemarno, S., Riniwati, H. and Afandhi, A. 2019. Forest revegetation to preventive springs degradation in Arjuna Mount East Java, Indonesia. Preprint, 20190802. 77: 1–18. DOI:https://doi.org/10.20944/preprints201908.0277.v1

[25] Onyango, A.E., Okoth, M.W., Kunyanga, C.N. and Aliwa, B.O. 2018. Microbiological Quality and Contamination Level of Water Sources in Isiolo County in Kenya. *Journal of Environmental and Public Health*, 2018: 2139867. DOI: https://doi.org/10.1155/2018/2139867

[26] Pambudi, A.S. 2021. Overview and evaluation of the Indonesias water resources management policies for food security. *Indonesian Journal of Applied Environmental Studies*, 2(2): 84–93 DOI:https://doi.org/10.33751/injast.v2i2.3586

[27] Rahdriawan, M., *et al.* 2021. Risks of community-based groundwater users in the transition to West Semarang drinking water supply. *IOP Conference Series on Earth and Environmental Science*, 724(1): 012081. DOI: https://doi.org/10.1088/1755-1315/724/1/012081

[28] Rakatama, A., and Pandit, R. 2022. Reviewing social forestry schemes in Indonesia: Opportunities and challenges. *Forest Policy and Economics*, 111(1): 102052. DOI: https://doi.org/10.1016/j.forpol.2019.102052

[29] Ram, N.R.S., *et al.* 2022. Multi-criteria based land and water resource development planning using geospatial technologies. In. Pandey, A., Chowdary, V.M., Behera, M.D., and Singh, V.P. Geospatial Technologies for Land and Water Resources Management: p. 103–123. DOI: https://doi.org/10.1007/978-3-030-90479-1_7

[30] Ridlo, M.A., and Ghiffari, A. 2022. Analysis of potentials and problems of Semarang city. *IOP Conference Series on Earth and Environmental Science*, 955(1): 2022. DOI: https://doi.org/10.1088/1755-1315/955/1/012018

[31] Rusydi, A.F. 2018. Correlation between conductivity and total dissolved solid in various type of water: A review. *IOP Conference Series on Earth and Environmental Science*, 118(1) DOI:https://doi.org/10.1088/1755-1315/118/1/012019

[32] Sari, S.Y.I., *et al.* 2018. Water sources quality in urban slum settlement along the contaminated river basin in Indonesia: Application of quantitative microbial risk assessment. *Journal of Environmental and Public Health*, 2018: 3806537. DOI: https://doi.org/10.1155/2018/3806537

[33] Sila, O.N.A. 2019. Physico-chemical and bacteriological quality of water sources in rural settings, a case study of Kenya, Africa. *Scientific African*. 2(3): e00018. DOI: https://doi.org/10.1016/j.sciaf.2018.e00018

[34] Siswo, C. W. Yun, and S. Abdiyani, 2019. Distribution of tree species around springs and trees-springs interplay possibility in the springs area of Soloraya, Central Java, Indonesia. *Forest Science and Technology*, 15(3): 128–139. DOI: https://doi.org/10.1080/21580103.2019.1626772

[35] Stevenson, M., and Bravo, C. 2019. Advanced turbidity prediction for operational water supply planning. *Decision Support Systems*, 119: 72–84. DOI: https://doi.org/10.1016/j.dss.2019.02.009

[36] Supangat, A.B., Purwanto, P., Hendrayana, H., and Riyanto, H.D. 2022. Springshed protection planning for combating drought in Grobogan District, Central Java. *IOP Conference Series on Earth and Environmental Science*, 1016(1). DOI: https://doi.org/10.1088/1755-1315/1016/1/012022

[37] Tantoh, H.B. and Simatele, D. 2018. Complexity and uncertainty in water resource governance in Northwest Cameroon: Reconnoitring the challenges and potential of community-based water resource management. *Land Use Policy*, 75(2): 237–251. DOI: https://doi.org/10.1016/j.landusepol.2018.03.044

[38] Wei, C. *et al.* 2022. An alternative to the grain for green program for soil and water conservation in the upper Huaihe River basin, China. *Journal of Hydrology: Regional Studies*, 43(10): 101180. DOI:https://doi.org/10.1016/j.ejrh.2022.101180

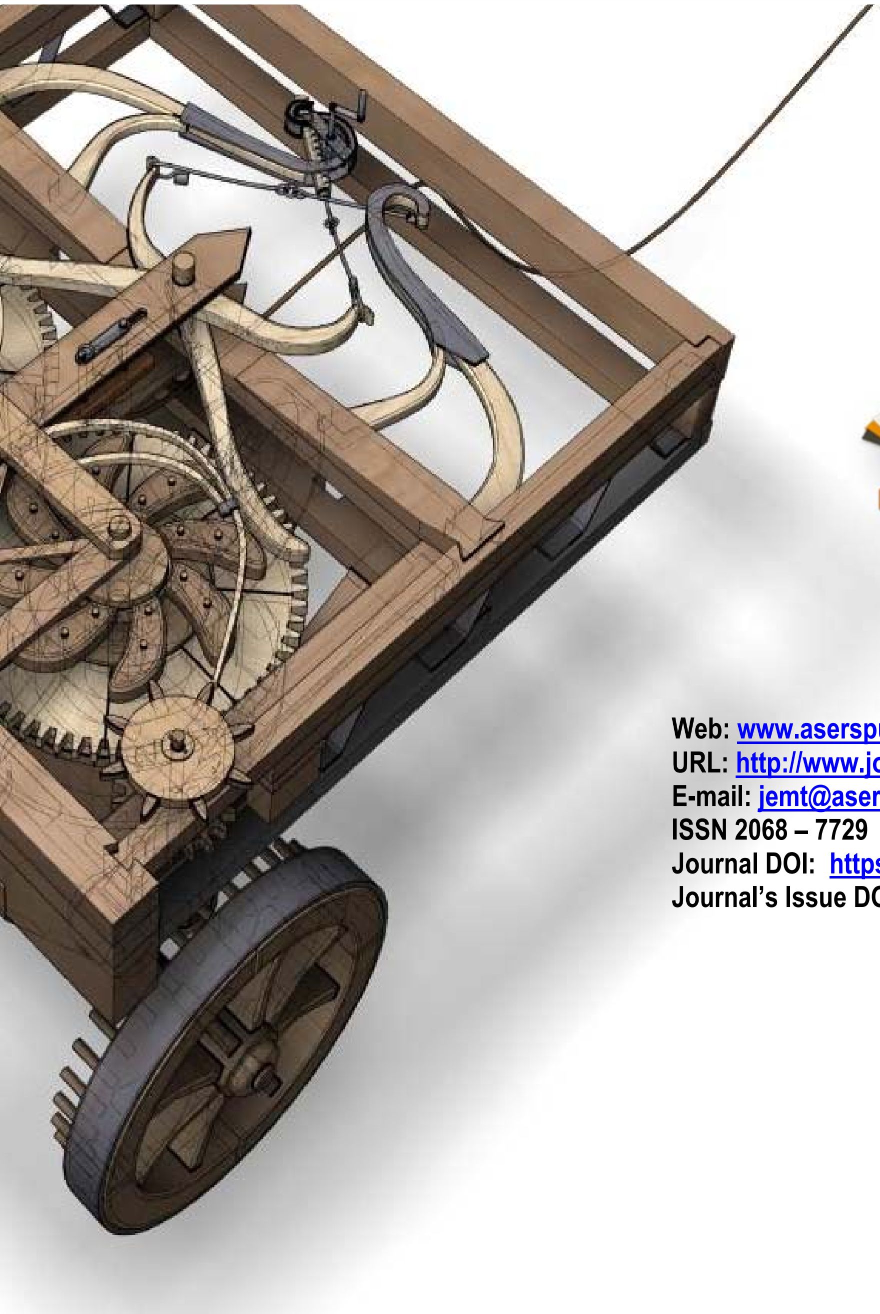
[39] Weinthal, E., Zawahri, N., and Sowers, J. 2015. Securitizing water, climate, and migration in Israel, Jordan, and Syria. *International Environmental Agreements*, 15(3): 293–307. DOI: https://doi.org/10.1007/s10784-015-9279-4

[40] Widodo, T. Budiastuti, M.T.S., and Komariah, K. 2019. Water quality and pollution index in Grenjeng River, Boyolali Regency, Indonesia. *Journal of Sustainable Agriculture*, 34(2): 150. DOI:https://doi.org/10.20961/carakatani.v34i2.29186

[41] Yulianto, T., Suripin, S., and Purnaweni, H. 2019. Zoning landslide vulnerable area according to geological structure, slopes, and landuse parameters in Trangkil Sukorejo Gunungpati Semarang City's Residental area. *Journal of Physics: Conference Series.* 1217: e012029. DOI: https://doi.org/10.1088/1742-6596/1217/1/012029

[42] Zinabu, G.M., Chapman, L.J., and Chapman, C. A. 2002. Conductivity as a predictor of a total cations and salinity in Ethiopian lakes and rivers: Revisiting earlier models. *Limnologica*, 32(1): 21–26. DOI:https://doi.org/10.1016/S0075-9511(02)80013-5

ASERS



ASERS Publishing

Web: www.aserspublishing.eu
URL: http://www.journals.aserspublishing.eu/jemt
E-mail: jemt@aserspublishing.eu
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt
Journal's Issue DOI: https://doi.org/10.14505/jemt.v14.1(65).00