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EFFECT OF TOLL ROAD CONSTRUCTION CIKAMPEK-PALIMANAN ON SOCIO-ECONOMIC IN KALIJATI DISTRICT OF SUBANG REGENCY

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Abstract

Kecamatan Pagak, Kabupaten Malang is an area which is dominated by karst landform. Basically, Karst is landform which is vulnerable to drought for the very minimum of waterflow surface. Underground river flows are more developed in karst landforms due to the large number of fractures. Based on these problems, this research seeks to solve the problem of water crisis in karst landforms by utilizing groundwater. It chose geomorphological approach to find the highly potential groundwater landforms so that these they can be used as groundwater infiltration zones. Geomorphological mapping is carried out by identifying aspects of morphology, morphogenesis, morphoarrangement, and morphocronology. Through the geomorphological mapping, it was obtained nine units of landforms in the research area. The P4Fv1 landforms are units that have high groundwater potential which can be utilized in large quantities.

Keywords: Kecamatan Pagak, Geomorphology, Groundwater

A. Introduction

Karst landforms are landforms that are formed as a result of the dissolving process of constituent rocks which are dominated by limestone by the power of water (Sugiyanta, 2017; Groves & Meiman, 2005). The development of karst landforms can be seen from the units in the area (Ford & Williams, 2007). In the developed karst landforms, there are many drainage systems in the form of underground river flows (Lewin & Woodward, 2009).

Indonesia, karst landforms spread from Aceh, Singkarak, and South Sumatra in Sumatra, the South Gombong Karst Area and Gunung Sewu in Java, the Mangkalihat and Meratus Mountains in Kalimantan, the Maros Karst Area in Sulawesi, the Waingapu Karst Area in West Sumba, to Trikora Mountains and Fakfak in Irian Jaya (Kantor Menteri Negara Lingkungan Hidup, 1999; Setiawan, 2015). Karst landform takes up 20% of the indonesia'a total area (Cahyadi et al., 2012). This landform is widely used as a residential area, mining, tourism, conservation area, and others. Even though they have various strategic values, the karst landforms have their own threats and potentials that should be paid more attention.

Drought is one of the threats that exist in karst landforms. This is due to the characteristics of limestone that are easily dissolved by water and the abundance of secondary porosity so that water does not accumulate on the surface, but in the underground river flow systems (Rachmi, 2018; Rajaveni et al*.,* 2017; Msadde et al*.,* 2019). As a result, aquifers are in a zone of high depth (Eltarabily & Negm, 2019; Bollollo & Perilli, 2018). It happens in the Kecamatan Pagak, Malang Regency.

Kecamatan Pagak is one of the districts in Kabupaten Malangwith a high level of drought threat. Pagak Village, Gampingan Village, Sumberjo Village and Sempol Village are villages with the highest level of drought vulnerability in Kecamatan Pagak (*Kodim-0818.id*., 2018; *Medcom.id.,* 2019). Especially, Sumberejo Village wich has the long day without rain (30—60 days).

So far, the Kabupaten Malanghas been responsive to handle the water crisis. It is shown with the dropping of clean water by Regional Disaster Management Service of Malang Regency. Handling of clean water problems should be preventive in nature so that it can cope with water crisis disasters in the long term. The ineffective water crisis management in Kabupaten Malanghas resulted in an increase in the number of areas experiencing water crisis. In 2018, Kabupaten Malang experienced a water crisis in 7 villages, then increased in 2019 to 11 villages in 7 sub-districts (*radarmalang.id.,* 2019).

One of the preventive efforts to handle the water crisis is through the use of groundwater. Besides, it needs to be coupled with groundwater management efforts to keep it sustainable. Groundwater management can be done with the application of the groundwater usage zoning system. The zoning system is based on the potential characteristics of groundwater. Meanwhile, groundwater potential can be identified through geomorphological mapping and identification of hydrological characteristics (Rehman et al*.,* 2019; Muniraj et al*.,* 2019). The hydrological characteristic can be inferred from the groundwater manifest of Kecamatan Pagak (Mishra & Singh, 2019; Frisbee et al*.,* 2016; Teixeira et al*.,* 2013; Gebrie et al*.,* 2018). Geomorphological conditions affect the condition of environmental precipitation during rock formation, rock mineral composition of aquifers, processes and patterns of groundwater movement in aquifers, and the length of time groundwater stays in aquifers or is trapped in one rock layer (Kudamnya et al*.,* 2019; Obiajulu et al., 2016; Djorfi et al*.,* 2018). It is expected that this research can be used as the intial identification in the groundwater management as a form of preventive solution to solve the water crisis through groundwater management.

B. Methodology

1. Research Design

It is a descriptive qualitative research applying three approaches, namely: interview approach, GIS (Geographic Information System), and observation. The process in this research is illustrated through the flow diagram in Figure 1.

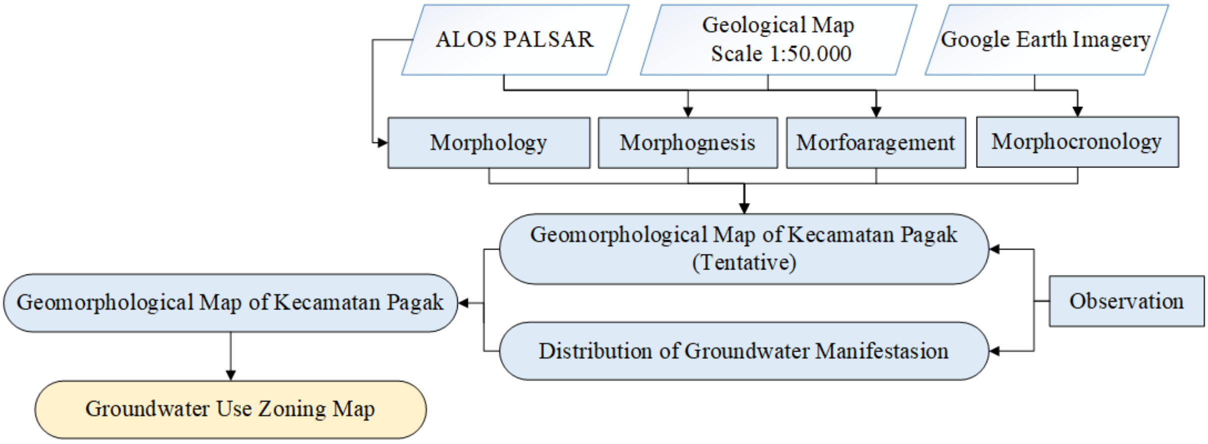

Figure 1. Research Flowchart

2. Instruments

Equipments and Materials

The equipments used in this study were Avenza Map and QGIS 3.12. Avenza Map is useful for navigation, documentation and storing or displaying the coordinates of observation points. The materials used are DEM (Digital Elevation Model) from ALOS PALSAR, Geological Map of 1: 100,000 Scale (sheet of Turen and Blitar) and Google Earth imagery.

Obtained Data

This research applies primary and secondary data. Primary data obtained through interviews and observations. Determination of respondents in the interview using the proportional sampling method, so that the respondents were taken in every village in Kecamatan Pagak which has a drought threat. Meanwhile, observation aims to look for groundwater manifestations. Groundwater manifestations are important as a basis for determining groundwater conservation zone. The secondary data in this study are used in geomorphological mapping (Ahiwar et al., 2020), as shown in the table 1.

Table 1. Research Seconday Data

No	Name of Materials	Usage	Source
1	DEM ALOS PALSAR	Topographic Analysis	Alaska Satellite Facility Data Search, United States of America
2	Geological Map Scale 1: 100.000; Sheet of Turen and Blitar	Geological Condition Identification	Geological Research and Development Centre, 1992
3	Google Earth image	Land Cover Identification	Google Earth, 2020

3. Technique of Data Analysis

Geomorphological Mapping

Geomorphological mapping is done by identifying aspects of morphology, morphogenesis, morphoarrangement, and morphocronology using remote sensing tools and GIS (Geographic Information System) (Kolli et al., 2020; Ardakani et al., 2020; Teixeira et al., 2013; Indhulekha et al., 2019; Avtar et al., 2010; Nigussie et al., 2019). The advantages of digital mapping using GIS is that it can speed up and be more accurate and improve data management (Pande et al., 2018; Srivastava & Bhattacharya, 2006; Nila et al., 2015). Geomorphological analysis in this study uses an analytical approach. The analysis stages include image processing, ground check, and updating the map (Malik et al., 2016). The table 2 gives a detail of each stage in the geomorphological analysis in this study.

Table 2. Geomorphological Analysis Stage

Stage	Analysis Tools	Source	Analysis / Processing Techniques
a. Image processing			
1. Deliniation of Kecamatan Pagak	• QGIS 3.12	RBI Digital	Digitizing on Screen
2. Morphological Analysis	• SAGA GIS • QGIS 3.12	ALOS Palsar	Visual / manual relief interpretation using Slope and Hillshade analysis (Verstappen, 1983)
3. Morphogenesis Analysis	• QGIS 3.12	• Google Earth Image • ALOS Palsar • Geological Map Scale: 1:100.000	Landform interpretation based on the origin of the process is done visually / manually through hue, color, shape, and texture in terms of the association of the geological material arrangement (Verstappen, 1983)
4. Morphoarrangement Analysis	• QGIS 3.12 • GRASS GIS	• ALOS Palsar • Geological Map Scale 1:100.000	Visual / manual interpretation uses slope analysis, hillshade, profiling, and reviewing the geological material association
5. Morphocrolonology Analysis	• QGIS 3.12	• Geological Map Scale 1:100.000	Enter geological material information in attribute data
6. Making Temporary Geomorphological Maps	• QGIS 3.12	Shp: Morphology Morphogenesis, Morphoarrangement, Morphocrolonology	Using a map overlay system
b. *Ground Check*			
1. Observation of External aspect	Avenza Map	Geomorphology Map	Observation
c. Map Update			
1. Geomorphological Map Reinterpretation			Reinterpretation based on observations in the field
2. Making Geomorphological Map	• QGIS 3.12	Temporary Geomorphological Map and Ground Check Results	Geomorphological Map Layout of Kecamatan Pagak, Malang Regency

Groundwater Manifestation Mapping

Groundwater manifestation mapping aims to predict the groundwater system in the research area Groundwater manifestations shows hydrological characteristics in the area, including through: the presence of springs, former dams, ephemeral rivers, intermittent rivers, perennial rivers, and lakes (Poi & Samanta, 2019; Pande et al., 2020; Nag & Chowdhury, 2019). The existence of these manifestations is obtained through observation and interviews. Interviews were conducted by asking questions to the speakers face to face or in person. It is conducted in-depth interviews and based on outlines of the problem (unstructured). This is so that the resource person can provide as complete information as possible. The results of the groundwater system estimation greatly contribute to the decision making for recommendations for bore wells in the infilling zone (Paul et al., 2020; Nigatge et al., 2020).

C. Findings and Discussion

1. Findings

From all villages in Kecamatan Pagak, Sumberejo Village is the most prone area to drought according to interview results from local community. Figure 2a is the visualization of water crisis impact in Sumberejo Village, which affected the clean-water availability for domestic purposes. In figure 2b, the local community of Sumberejo Village has been trying to mitigate by doing rain-harvesting. For that reason, water crisis mitigation effort needs to be prioritized in Sumberejo Village as the most prone area to the crisis.

Figure 2. Water Crisis Ilustration in Sumberejo Village, Kecamatan Pagak

The distribution of groundwater manifestation in the form of springs, perennial rivers, and reservoir are more abbudant in the northern part of Kecamatan Pagak. Springs are associated with break of slope in M1S2 landform. Meanwhile, perennial rivers and reservoirs are more common in P4Fv1 landform. However, perennial rivers can also be found in the southern part of Kecamatan Pagak on U3K3 landform. Therefore, the shallow groundwater potential in P4Fv1 and U3K3 landforms are predicitly high as perennial rivers are the most significant factor to identify groundwater. Shallow groundwater is located with maximum depth of 15 meters below the surface (Saparudin, 2010).

The results of geomorphological mapping show that there are nine geomorphological units as in Table 3 and Figure 3.

Table 3. Geomorphology Unit of Kecamatan Pagak, Malang Regency

No	Landform Unit	Morphology	Morphoarrangement	Morphogenesis	Morphocronology /Surface Material
1	H3K2	Hilly	Lower Slope	Solutional	Lithology Group B
2	H2K4	Hilly	Middle Slope	Solutional	Lithology Group D
3	H2S2	Hilly	Middle Slope	Structural	Lithology Group B
4	U3K3	Undulating	Lower Slope	Solutional	Lithology Group C
5	U3K2	Undulating	Lower Slope	Solutional	Lithology Group B
6	M1S2	Mountainous	Upper Slope	Structural	Lithology Group B
7	U2D5	Undulating	Middle Slope	Denudational	Lithology Group E
8	P4Fv1	Plain	Plain	Fluviovolcan	Lithology Group A
9	U2K3	Undulating	Middle Slope	Solutional	Lithology Group C

Source: Author's Analysis, 2020

Generally, Pagak Subdistrict has limestone surface material (Table 4). This is due to the presence of the Nampol Formation (Tmn), the Wonosari Formation (Tmwl), the Mixed Land Formation (Tmcl), and the Wuni Formation (Tmw) as the rock forming the area. Technological activity in the form of lifting the seabed causes these formations to be formed. In contrast to the Tuff Volcanic Tuff Formation (Qptm) which is formed through the fluviolizing process. Where the fluvial process is triggered by the presence of the eradicate river which carries the material from the volcanic process of Mount Arjuno-Welirang, Anjasmoro, Butak-Kawi and Bromo-Semeru. This volcanic tuff deposition formation is a formation that has high groundwater potential because the lithological constituent materials of coarse-fine tuff, pumice, andesite fragments and alluvial materials tend to be able to store water better.

The geological condition of an area can affects the respons of the rock material to water, whether to store or to release it. Therefore, groundwater exploration can be started from the geological and/or lithological condition of an area. For groundwater harvesting purposes, the lithological condition in the aquifer is categorized as ideal if the rock material can both store and release water well. Sediment rocks are best to do both works due to its relatively coarse pores (porous). Such condition is also applied in a Volcanic Tuff Deposits (Qptm) geological formation; thus, it acts as the aquifer layers.

Table 4. Surface Material Description

Lithology Group	Lithological Information	Geological Formation
A	Coarse-fine tuff, pumice, andesite fragments and alluvial materials	Volcanic Tuff Deposits
B	Limestone, sandy marl, claystone intercalations	Wonosari Formation
C	Tuff or limestone sandstone, black claystone, sandstone marl and limestone sandstone	Nampol Formation
D	Crystalline limestone and claystone intercalations	Land Mix Formation
E	Basal andesite lava and breccias, tuff breccias, lava breccias	Wuni Formation

Source: Geological Map Scale 1: 100.000 (Sheet of Turen and Blitar), 1992

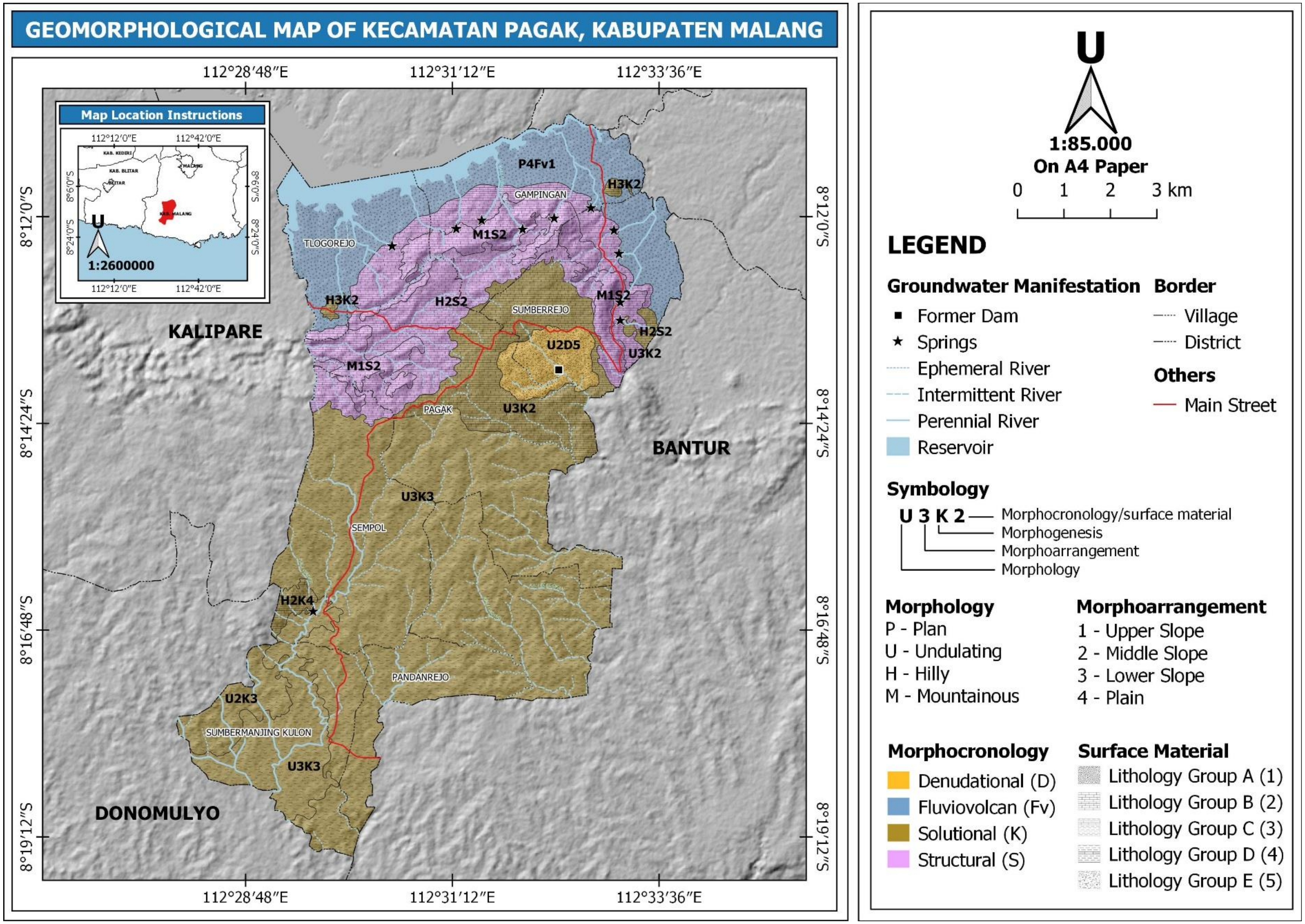

Figure 3. Geomorphological Map of Kecamatan Pagak, Malang Regency

2. Discussion

Groundwater Usage Zoning

Utilization or pouring of groundwater to meet water needs in daily life must refer to the principle of balance and suitability of potential (Santosa & Tjahyo, 2014). Based on this, an appropriate zoning for groundwater use is required. Groundwater use zoning or groundwater conservation in this study is prepared based on three systematic considerations aquifer characteristics, groundwater potential zoning, and geomorphological conditions. Based on these three considerations, the direction of the groundwater use zone can be determined. The following are directions for groundwater use in Kecamatan Pagak:

a) The Protected Forest Zone (low groundwater potential) is marked in red on the map (Figure 7). This zone is located in the geomorphological unit area of M1S2, U3K2, U2K3, H2K4, and H2S2. Infiltration zone 3 is a group of free groundwater with a limited inflow intensity. This is due to several factors including: 1) thin aquifers, 2) distribution of groundwater at a local scale, and 3) availability of groundwater is limited, but has good quality (class 1).

b) The Infiltration Zone (medium groundwater potential) is marked in Yellow on the map (Figure 7), this zone is located in the H3K2, U3K2, and U3K3 geomorphological units (Yellow). This zone is medium aquifer and productivity is quite high. This zoning is based on free groundwater with a limited intensity of deposition. This is due to the inhibiting factors in the form of good quality (class 1) to moderate (class 2). The existence of this factor is due to the condition of the area which has been mostly used for residential and industrial use, so that groundwater in this zone has a high threat of contamination with lime, e-colli, and nitrate.

c) The Deposition Zone (high groundwater potential) is marked by green on the map (Figure 7), this zone is located in the U3K3 (Green) and P4Fv1 geomorphological units. The determination is based on free groundwater which can be utilized in large quantities. This is caused by the lack of inhibiting factors in groundwater depth. Implantation zone 1 is characterized by thick aquifers with large amounts of groundwater productivity. In addition, the distribution of soil in this zone is quite wide with good quality (class 1).

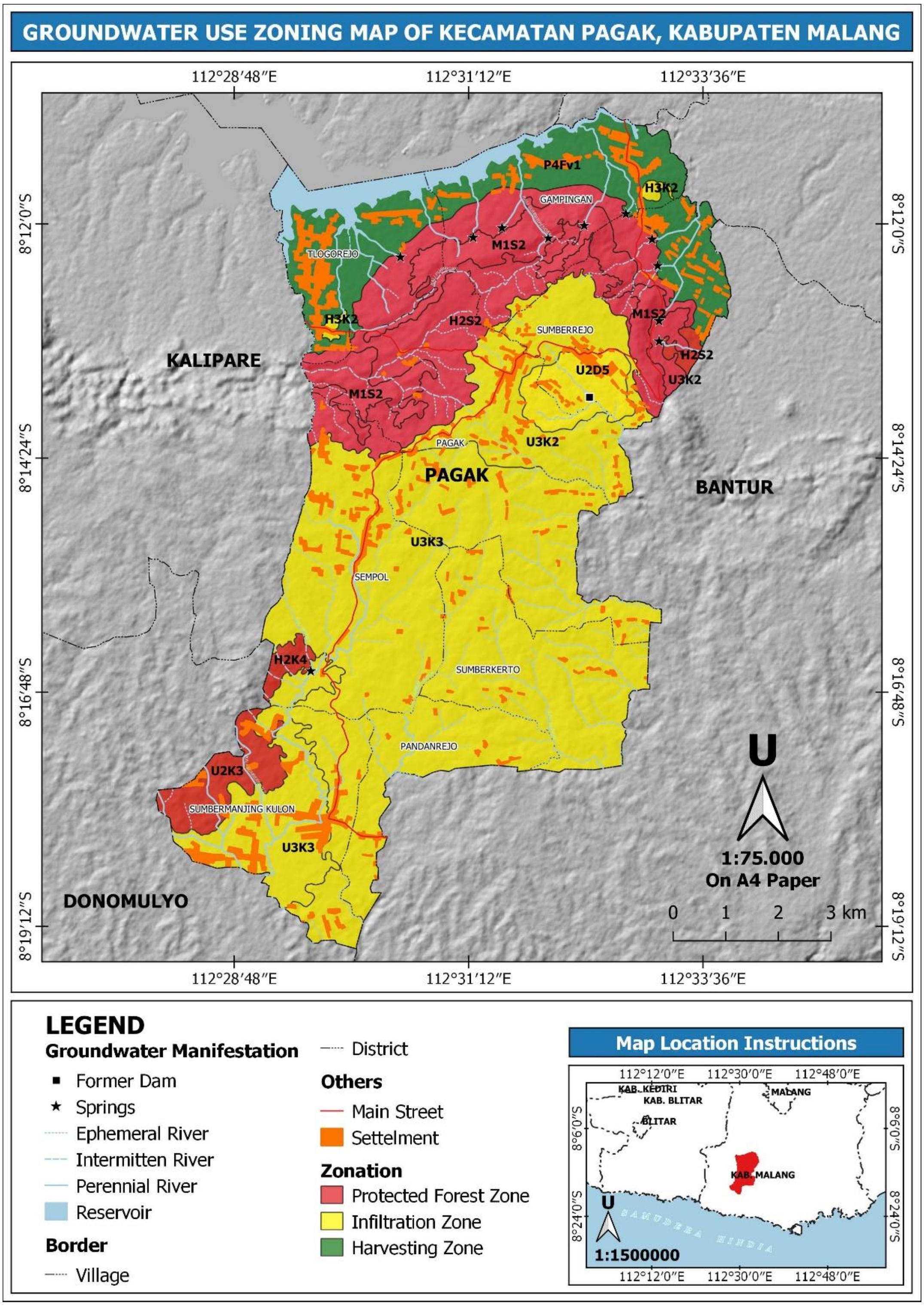

Figure 4. Groundwater Use Zoning Map

D. Conclusion

Efforts to deal with the water crisis can be resolved by efforts to utilize groundwater and conserve groundwater. Through geomorphological mapping and mapping of groundwater manifestations in this study. Three zones of groundwater use are established:

1. The Protected Forest Zone (low groundwater potential) is marked in red on the map (Figure 7). This zone is located in the geomorphological unit area of M1S2, U2K3, H2K4, and H2S2.
2. The Infiltration Zone (medium groundwater potential) is marked in Yellow on the map (Figure 7), this zone is located in the H3K2, U3K2, and U3K3, and U2D5 geomorphological units. This zone is medium aquifer and productivity is quite high.
3. The Harvesting Zone (high groundwater potential) is marked by green on the map (Figure 7), this zone is located in the P4Fv1 geomorphological unit. The determination is based on free groundwater which can be utilized in large quantities.

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