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AVAILABILITY OF WATER SUPPLY FOR THE WONOSARI - WONOGIRI AREA, YOGYAKARTA SPECIAL PROVINCE

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ABSTRACT

Shortage water supply always experienced by the inhabitants of kasrtik area of Wonosari - Wonogiri, more over during the dry season. During the rainy season people can use rain water to fulfill their domestic water demand, and in some locations dig wells are also available. However during the dry season people have to go 1 to 5 km and spending almost one day to go to the spring or underground river to get 20 liters water.

In order to improve the water supply condition of Wonosari – Wonogiri area, some filed and desk study have been done. These studies found some potential sources such as lake water, spring water, underground rivers water, and groundwater. Groundwater is the best in quality but there is a problem of exploitation and distribution for the local people. Underground rivers water are also available in many places but the problem is about the same as for groundwater. Lake water and spring water are the most easily used by the local people. However the distribution of water sources is not consistent with settlement distribution and this water prone to water pollution from cattle and sediment run off. There is no any water management system yet. The increasing population and water demand will give big threat to these water sources. It is urgently needed to introduce appropriate good exploitation, management, and conservation of water system to maintain the continuity of water supply.

Keywords: water supply, Wonosari-Wonogiri area

1. INTRODUCTION

Wonosari and Wonogiri area in the Special Province of Yogyakarta is typical arid area with only short rainy season (3 - 4 months) every year. There is no surface stream water body available. Lack of water supply is common situation in this area. People live in this area are hardly possible to fulfill their water demand, especially during the dry season.

Limestone in various types is the main rock underlining this area with some minor sandstone and alluvial in many places. The soluble limestone is leached by rain water during rainy season producing cave, underground river, and small hills. Rain water fall in this area mostly percolating down through secondary porosity (crak and sollution channel) and form underground river or emerges as spring. Some part of precipitation water my be retarded in the depression area as lake water.

There are some alternative sources of water supply, in different quantity and continuity. Groundwater is potentially found in some different location and depth. However to exploit this ground-water required big effort for exploration, exploitation and distribution. Underground rivers water are identified in some locations and some of them have been used. Some of the groundwater and underground river waters are also emerge in the ground surface as spring water. Surface waters in the form of lake of various sizes are irregularly distributed in the area. This paper aims to discuss the availability of water sources for this region and the alternative solution to fulfill water demand.

2. DESCRIPTION OF STUDY AREA

Wonosari and Wonogiri districts are located in the Southern part of the special province of Yogyakarta. The physiography of the area is characterized by undulating morphology with some isolated hills and depression (kasrtic morphology). This 'karstik' morphology is the product of the dissolution of soluble limestone by precipitating water during the rainy season letting small hills remain, depression area and cave.

The geology of the area mainly underlain by soluble limestone (Wonosari - Punung Formation) with some limited sandstone in some localities. According to Surono *et al.* (1988) besides limestone, some rocks underlining this area are volcanic breccia, agglomerate, andesite lava, tuff, andesite intrusion, pumice rock, tuffaceous sand, and shale. The Wonosari Formation, coral reef limestone, based on morphological and physical investigation can be divided into four groups or facies (see Figure 1) namely :

1. *The lower slope facies* composed of well layered packstone, 5 to 15 cm thick, big foraminifera fossil and bentos. Weathering process in the boundary layers has facilitated space for entrance of water which then produce cave. This facies mainly found in the northern part of the study area.

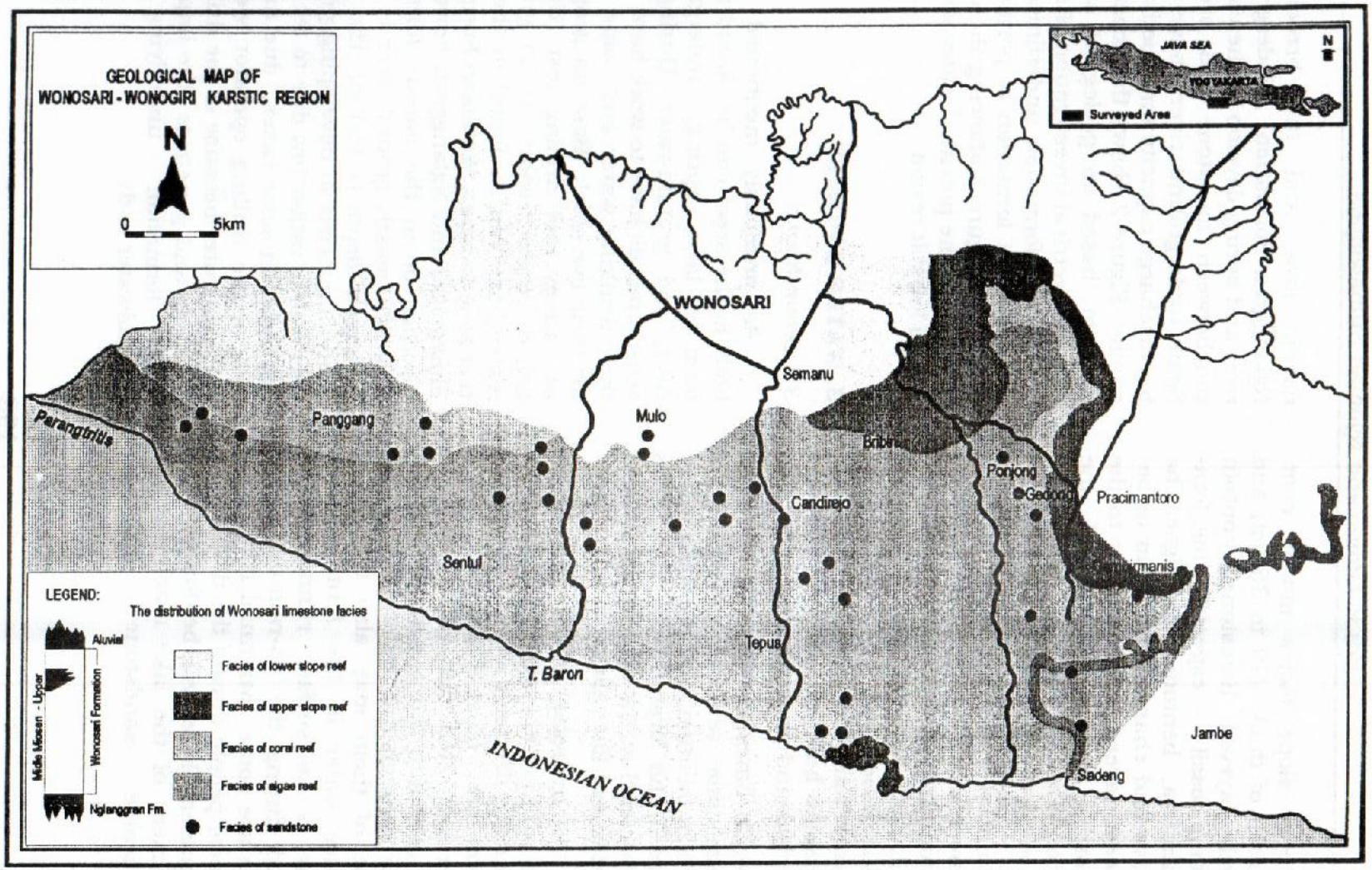

Figure 1 : Geological map of Wonosari-Wonogiri Karstic Region

2. Upper slope facies mostly composed of thick (10 to 35 cm) and well layered limestone, contain some fossil --- especially big foraminifera, bentonic, and algae. The cave and channel that form in between layers mostly sloping to the north, making most of the groundwater in this formation flowing to the north (lower slope).
3. Coral reef facies consist of thick (more than 1 m) layer limestone (boundstone) with some coral fossil, mollusca, and algae. In the filed this facies can be identified as hard limestone, steep slope hill (pepino hill) and narrow valley and only found in small area.
4. Algae limestone consist of algae limestone and characterized by slight foliation, abundant algae ball fossil and foraminifera. This facies spreaded in the area in the form of wide and flat valleys.

The hydrology of the area is typical of arid karstic region; the diversion of surface drainage into underground stream flow. Most of the precipitating water saturated with carbonate solution goes into the sea as surface run off or through the underground river. Some of them may also remain as surface water in the form of lake. There is no surface running water found during the no-rain-day; but there are some perennial lakes used by local people during the dry season. Permanent lake will be found when basement of the lake reach the impermeable sandstone formation, dacitic lava, and tuff breccia of Nglanggran Formation. Underground river and spring develop in the contact zonebetween limestone and breccia. Some underground rivers have quite big discharge capacity and good water quality. Figure 2 shows the schematic diagram, based on geological survey and geoelectrical investigation showing the geology formation underlining the area and the formation of permanent lakes and Figure 3 showing the distribution of some potential water sources in this karstik region.

3. WATER SOURCES

3.1 Groundwater

As previously mentioned water body in the area can be found in the form of lake, spring, underground river, and groundwater. During dry season people have to work hard to get their drinking water and some water for their live stock. Base on geophysical survey and drilling test (Unpublished Project report, 1992) groundwater body can be found in the contact zone between Wonosari Formation (limestone) and Nglanggran Formation (breccia) or in the porous formation however mostly groundwater is found in a great depth (> 150 m). The possibility of success in developing production well is rather low due to technical difficulty. In some cases; due to careless of the drilling operator we may lost our water because of the drill hole too deep and penetrate the impermeable formation underlying the groundwater body.

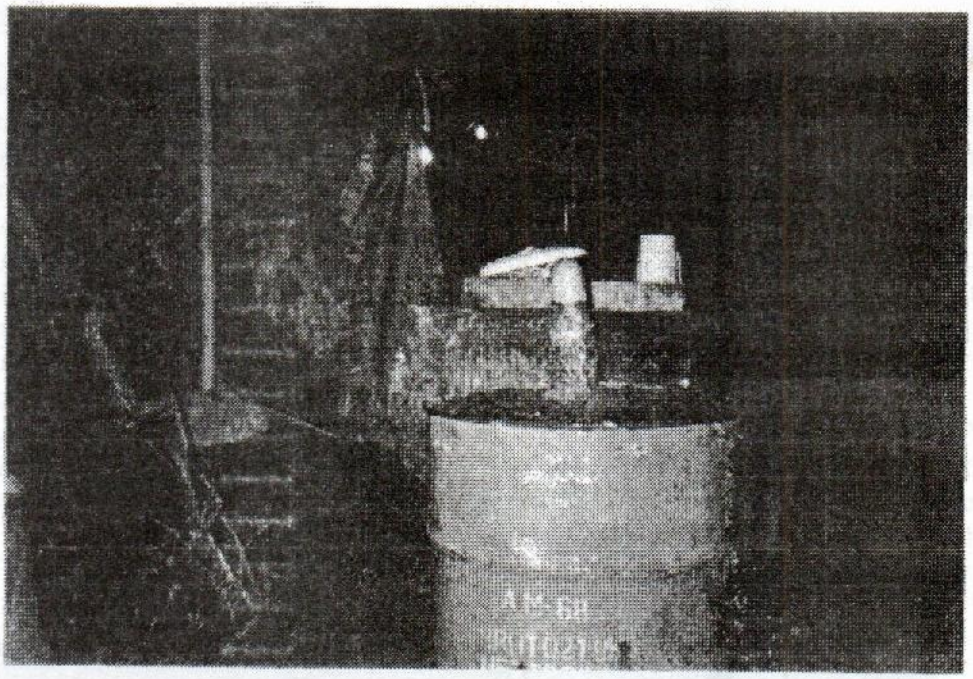

Photo 1. Groundwater discharge during 48 hours pumping test.

Table 1. Groundwater Quality Data (Well No. SE01-LIPI)

No	Parameter	Unit	Sample data	Standard value*	
				Drinkking	Agriculture
1	Ph	-	7.9	6.5 – 8.5	
2	EC	µS/cm	645	-	-
3	HCO_3^-	mg/l	447.06	-	-
4	Cl^-	mg/l	9.94		
5	SO_4^{--}	mg/l	25.0	400	
6	Na^+	mg/l	14.99		
7	K^+	mg/l	1.47	200	
8	Ca^{++}	mg/l	123.02	-	-
9	Mg^{++}	mg/l			
10	Hardness ($CaCO_3$)	mg/l	350.07	500	-
11	Na	%	8.96	-	60
12	SAR	-	0.35	-	18
13	RSC	-	7.64	-	1.25 – 2.50

* Ministry of Environment (Kep-02/MEN KLH/I/1988)

Some production wells have been developed in the area with various success degree. One production well (TW 58) at Suci Village (Pracimantoro Sub District) of 130 m depth fail to get economical discharge rate and unfortunately should be abandoned. The other production well is TW 62 (130 m depth) at Suci Village produce only 0.16 lt/second.

3.2 Underground rivers

Underground-river-water may also be exploited for water supply. But again to use this type of water need big survey work to find the permanent flowing underground river. The other difficulty in exploiting the underground river is its distribution is not coherence with the population distribution. People usually live in small group (10 to 20 houses) in the area considered fertile for cultivation. In some case they can only make their house on the land available, not base on water availability. The other constraint is water quality. Water quality of underground river is also rather poor (need some treatment). As shown in Photo 2 this discharge is rather milky in color and also potentially carrying some contaminant.

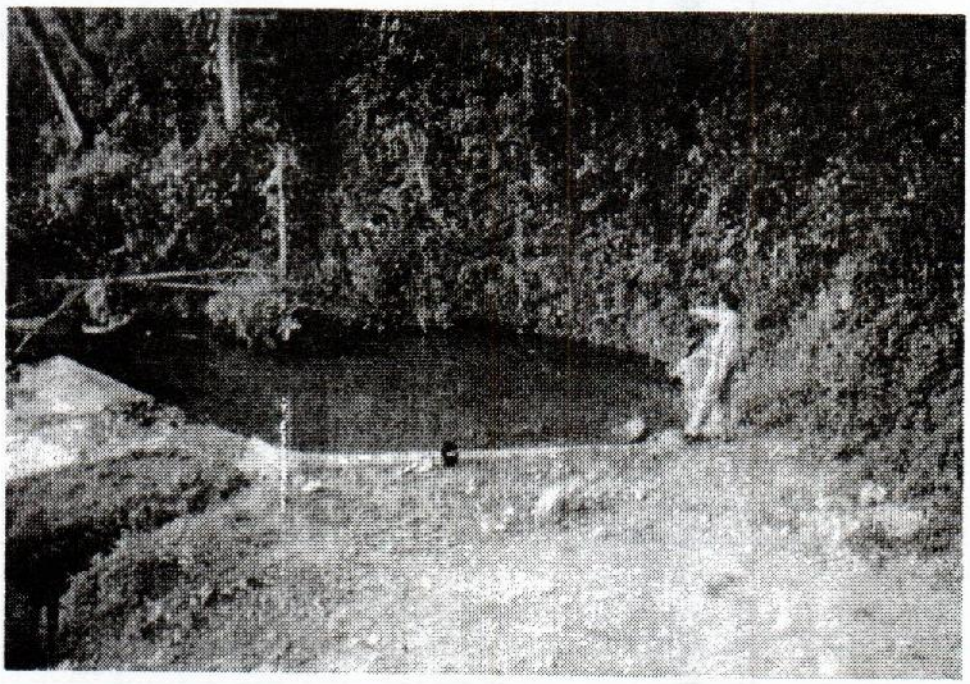

Photo 2. Outlet from Underground river (color rather milky white) near Gunung Batur Hill.

3.3 Lake water

The occurrence of permanent lakes: beside determined by the impermeable base is probably also in contact with groundwater body which is connected with the lake through porous geologic formation. The permanent lake is gaining in connection with the groundwater body. When the water level of the lake drop, water will flow to the lake from the groundwater body.

Lake is a depression area in between limestone hills of karstic morphology. Permanent lake will be found when the bottom of the depression reach impermeable rock such as sandstone, marl or shale. There are many lakes in various size and type found in this area. In some part of the area permanent lakes may also be found. There are about 40 permanent lakes counted and some of them have been used by directly taking the water from the lake. Permanent lake usually used during the dry season. During rainy season people can still get water from perennial lake or from shallow dig well. During dry season surface water supply only available in the permanent lake and underground rivers or spring.

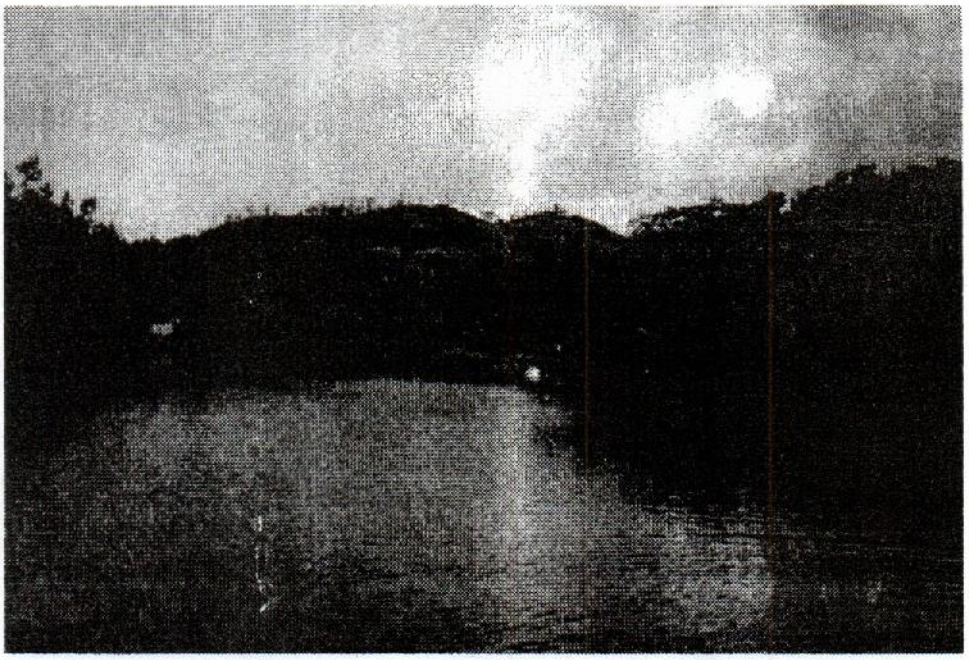

Photo 3. Permanent Lake near Gunung Kunir Hill (greenish indicating development of algae)

Table 2. Some data of physical characteristics of dig well and spring water measured in the field.

Location (village)	Type of water source	Depth (m)	Water level (m)	Color	Turbidity	Smell	T °C	pH	EC µS/cm	Output (lt/s)
Djuwangi	Dig well	9	2.7	nil	nil	nil	27	6.8	260	-
Puwun	Dig well	8	3.45	nil	nil	nil	27	7	440	-
Plawon	Spring	2	2	nil	nil	nil	27	6.6	400	0.3
Guntur	Dig well	8	3.2	nil	nil	nil	27	6.8	330	-
Pelem	Spring	-	-	nil	nil	nil	26	6.9	440	0.26
Dringo	Srping	-	-	Nil/ white	trace	nil	28	6.8	530	16

(Adapted from : Utomo E.P., *et al.*, 1995)

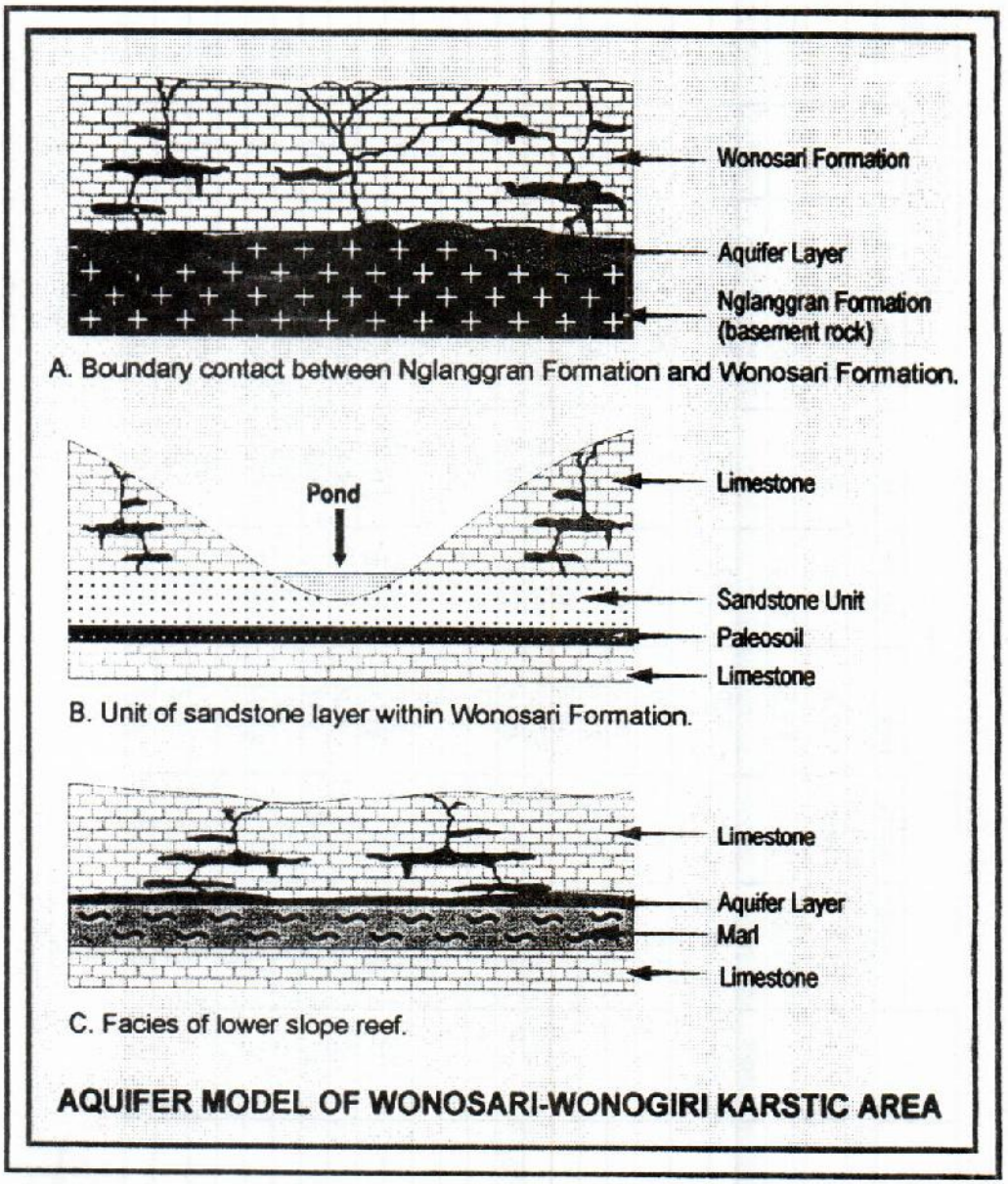

Figure 2. Schematic Geological Cross-section (showing potential water sources).

Table 3. Some Chemical Analysis Data of Dig Well and Spring Water of Wonogiri Area (Analyzed by Soil and Water Division Lab. Of R&D Center for Geotechnology)

No.	Parameter	Unit	Location						Water Quality Standard (Kep-02/MEN KLH/1/1988)			
			Djuwangi	Guntur	Goa Suci	Dringo	Weru	Waru	A	B	C	D
	Physic											
1	Temperature	°C	27,00	28,00	27,00	28,00	27,00	28,00	-	-	-	-
2	DHL	Ω S/cm	550,00	330,00	530,00	310,00	440,00	460,00	-	-	-	2250
3	Turbidity	mg/lt	-	-	-	-	-	-	-	-	-	-
		SiO2	1,25	0,4	0,30	0,80	0,50	0,75	5/25	-	-	-
	Chemical											
4	pH		7,30	6,90	6,90	6,80	6,90	6,80	6,5-8,5	5-9	6-9	5-9
5	Alkalinity	mg/l	411,48	758,52	764,24	1234,80	720,28	882,00	-	-	-	-
6	Ca	mg/l	101,80	189,07	210,89	276,34	196,34	239,98	200	-	-	-
7	Mg	mg/l	25,85	65,36	24,62	32,88	38,28	46,79	150	-	-	-
8	Hardness,$CaCO_3$	mg/l	254,50	472,68	527,23**	690,85	490,85	599,95	-	-	-	-
9	Hardness total, $CaCO_3$	mg/l	362,21	745,01	629,81	827,85	650,35	794,91	-	-	-	-
10	Na	mg/l	5,56	22,88	1,83	6,39	2,66	8,59	-	-	-	60%
11	K	mg/l	3,58	3,43	0,39	0,82	ttd	0,92	-	-	-	-
12	SO_4	mg/l	5,25	13,00	1,95	1,50	1,25	4,90	400	400	-	-
13	Cl	mg/l	15,42	22,27	32,59	12,49	13,04	23,90	600	600	-	-
14	HCO_3	mg/l	502,15	925,39	932,37	1506,46	878,75	1076,04	-	-	-	-
15	CO_3	mg/l	11,76	23,52	46,16	76,44	29,40	58,80	-	-	-	-
16	NO_3 - N	mg/l	0,27	0,46	0,19	0,54	0,15	0,03	10	10	-	-
17	NO_2- N	mg/l	ttd	ttd	ttd	ttd	ttd	ttd	nihil	1	0,06	-
18	NH_3- N	mg/l	0,001*	0,0004*	0,0002*	0,0002*	0,0001*	0,0001*	nihil	0,5	0,016	-
19	NH_4-N	mg/l	0,21	0,11	0,05	-	-	-	-	-	-	-
20	Mn	mg/l	ttd	ttd	ttd	ttd	ttd	ttd	0,5	0,5	-	2
21	Fe	mg/l	0,18	0,30	0,06	0,16	0,20	0,16	1	5	-	-
22	SAR	mg/l	0,23	0,35	0,03	0,10	0,05	0,13	-	-	-	0,5

Remark:

* = ministry of environment (Kep-02/MEN KLH/1988)
** = government regulation (PP/02/1990)
ttd = non detected (reading same as standard)

A = standard water for directly drinking
B = raw water can be treated for drinking water
C = water for fishery
D = water for irrigation, industry and power generation

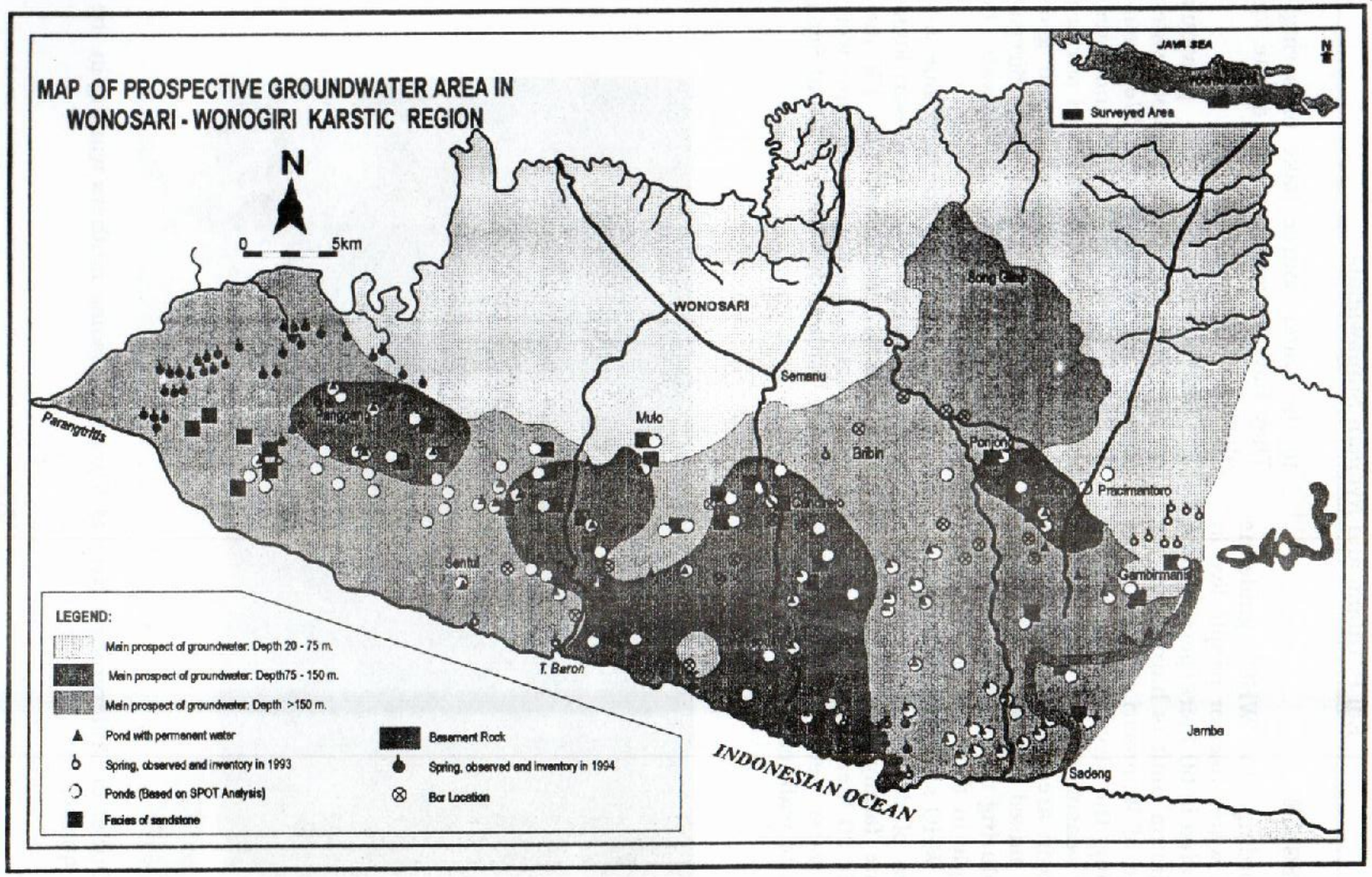

Figure 3. Map of Distribution of Some Potential Water Sources in the Wonosari – Wonogiri Kartstic Region

4. DISCUSSION

According to WHO guideline minimum water use for people live in the rural area is 60 liters/person/day. This minimum limit is hardly met for the people of Wonosari and Wonogiri area during the dry season. During the rainy season people of Wonosasi and Wonogiri area can fulfill their water need based on WHO standard. However during the dry season majority of people in this area live in water below the WHO standard (quantity). In the reason of difficulty finding water supply one family of 4 person may only live in 20 liters water per day. To get their water need, people of this area have to walk or travel 4 to 6 km to the water source (lake or spring). They have to join the long queue for about half day.

As mentioned in the previous section there are three possible water sources for people in the Wonosasi-Wonogiri area namely groundwater, under-ground river water, and surface water. Base on geological and geophysical study Utomo and Siregar (2000) concluded that groundwater is potentially

found in the contact zone between Nglanggran and Wonosari Fomration in a depth more than 150 meters. This indication, for example were found around the Batur hill and Song

Photo 4. Outlet of Underground river at 'Gua Suci' (some mothers waiting in the queue)

Gilap hill. However there many kinds of constraint for success in finding groundwater. Based on geoelectrical data the underground rivers could be found in three depth zone; 22 – 75 m; 75 – 150 m; and in the depth more than 150 meter.

The other potential water source is underground rivers water. This flowing water sources are expected to be found on coral reef rock, algae limestone, and in the upper slope coral. Photo 2 and 4 show two discharge outlet of underground river. In Photo 2 can bee seen that water color is rather milky showing over saturation of suspended material (carbonate). In Photo 4 some mothers waiting in the queue to get some liters water.

The third potential water source is lake water. More than 40 permanent lakes can be found in the Wonosari-Wonogiri Karstic Region. Some of them have been used traditionally by local people. This lake water is potentially carrying some domestic pollutant (algae formation indicating the present of phosphorous in the water). Lake water is the most easyly used by local people. However this water body is very fragile to contaminant carried by surface run off and any other mechanism. There is no data of chemical analysis of the lake water. For comparison Table 1, 2 and 3 are presented here to show that even for shallow groundwater (dig well and spring) there is indication of water pollution, especially dimestic pullutant indicated by NH_3-N. During the survey time perennial lakes are used for water supply directly (without treatment) for drinking water and any other water uses.

To use the permanent lake water as the domestic water supply, conservation action should be taken to minimize the potential pollution such by fencing, construction of sediment trap around the lake. Management strategy should be seek to get the optimal benefit of the lake.Physical and chemical treatment should be made also, especially chlorination. Government, especially the government of Special Province of Jogyakarta should take part in facilitating the development of Cooperative group (Koperasi) for the water users.

5. CONCLUSION

Three kinds water sources (groundwater, inderground river and lake) are availbale in the Karstic region of Wonosari-Wonogiri area. Groundwater is the best in quality but technoical problem for exploitation is also the highest. Sholoow groundwater and underground river water may contain some domestic or agriculture pollutants. Lake water is the most easyly exploited for domestic water supply, but some treatment are needed and conservation program should be made.

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