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SOLUTIONS TO EXPLORE AND USE REASONABLY THE UNDERGROUND SOURCES IN THE $T_2a\check{d}g$ AQUIFER IN THE SOUTHWEST REGION OF HA NAM PROVINCE

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Abstract: *Southwest of Ha Nam province distributes valuable aquifers in the Triassic limestone formations of Dong Giao formation (T2ađg). This aquifer is of good quality and has an average reserve and is being exploited for a variety of socio-economic purposes. However, the exploitation of this aquifer has not been planned, there are large water exploitation projects but there are also many small exploitation projects. This exploitation has affected the quality, reserves of water in the aquifers, causing pollution and depletion of water resources. Research results show that aquifers which are related to surface water, water in Quaternary aquifer are influenced by water sources mentioned above.*

The article mentions the situation of water resource exploitation in the reservoirs of $T_2a\check{d}g$ and proposes solutions to exploit and protect the aquifer for rational and sustainable exploitation and protection of the water environment from being contaminated and depleted.

Keyword*: exploitation, reasonably use, Ha Nam*

Introduction

According to the announced results of many authors, the southwest region of Ha Nam Province exists a fracture aquifer, fracture - Karst. This is a very rich aquifer. The quality and reserves of water in the aquifer ensure large-scale exploitation. However, there are currently constructions of water exploitation in these formations with different scales. Massive water exploitation without planning and management has been causing bad impacts on water quality in the area.

For Karst groundwater, there are many factors affecting quality and quantity such as rainfall, terrain characteristics, river network, distribution depth of the aquifer, composition and degree of soil cracking, waste sources, agricultural activities and mining exploitation in the area, degree of water exploitation ... These factors strongly affect the quality and quantity of water in the aquifer. Therefore, the solution to exploit and use reasonably the underground water sources in $t_2a\check{d}g$ aquifer in the southwest region of Ha Nam province is an important and

necessary issue. The solution will contribute to the protection, effective exploitation and use of water resources in the aquifer sustainably.

Research Methodology

To study the factors affecting the underground water environment in southwest region of Ha Nam province, the authors have used the following research methods:

+ Method of collection;

+ Method of field survey;

+ Method of synthesizing and evaluating documents;

+ Expert method;

+ Method of sample taking and analysis.

Results of research and discussion

3.1. Characteristics of underground water environment in southwest region of Ha Nam province

On the basis of the collected data and the results of the field survey, exploitation drill it is found that the study area has aquifers in the order of top down as follows:

Holocene porous aquifer (qh)

The Holocene aquifer has a very wide distribution area that covers most of area of the province except for the exposed areas of the original rock. The Holocene aquifer consists of sediments of various origins, which are interlaced; the upper part is silk clay with 1-3m thickness without water containing capacity. Only fine sand to medium layers of sand are capable of containing water. The water containing sediments distribute very wide. The main component is sand, and mixed with silk clay. This is the main aquifer and the main object. The thickness of the aquifer is quite stable. The thickness is usually between 10-20 m and the thickness decreases to the west. In Diep hill area and mountain ranges in Kim Bang, Thanh Liem, thickness of aquifer is beveled thinly and completely lost. The aquifer has a hydraulic relationship with surface water. Boreholes TD03, TD05DP, TD06, TD22BS and TD23BS in this study also have this aquifer at an average depth of 7.0 m to 15.0 m, composed of small black gray sand.

A series of drilling holes in Phu Ly area when pumping test for 2-3 hours show a clear sign of the water supply boundary from river. Long-term monitoring results also show that groundwater and surface water have a relatively tight hydraulic relationship. The supply source for the aquifer is rainwater on the permeable area.

Fracture aquifer, fracture - Karst (t_2ađg)

The t_2ađg aquifer is located in the west of Kim Bang and Thanh Liem districts. Research results in many boreholes in the area indicate that this aquifer is very rich in water and that the level of containing water is not even. Boreholes in the study area have this aquifer at a depth of 2.2 m (TD02) to 21.0 m (TD07DP). The boreholes have quite great reserve which varies in a wide scale, and there are also boreholes without water. The very unequal level of containingwater is also a characteristic feature of the Karst aquifer. Inner water is non-pressure and has local pressure intertwined.

This is one of the factors that make water in the aquifer relate directly with water in the porous sedimentary of the

quartenary. Therefore, if the porous aquifer is contaminated, there will be the risk of contamination of the fracture aquifer. The supply source for the aquifer is rainwater falling on the permeable area. By monitoring, it has been calculated that the vertical permeability coefficient in limestone is 0.002141. Water is discharged by surface waterways (Day River) and by supplying to nearby aquifers. Underground water is directly influenced by meteorological and hydrological factors. In rainy seasons (7, 8, 9), the groundwater level is markedly increased. In dry season, water level is the lowest. Because the $T_{2a}đg$ layer is rich in water, it should be an important target for underground water finding, exploration and exploitation.

There are also very poor or no water geological units in the study area that have no meaning in survey for water supply.

3.2. Factors affecting the groundwater environment in the region

3.2.1. Natural elements

- Terrain: The terrain of study area is mainly limestone so its terrain is complex. Groundwater is mainly supplied by rainwater but due to the steep terrain, rainwater largely creates the flow of water on the surface and drifts away. Because the amount of infiltration is smaller than in other areas, the supply of underground aquifers is less than in other areas.

Coating Thickness: Coating thickness plays an important role in increasing or decreasing the amount of additive from rainwater. However, the coating also plays an important role in preventing contaminants from entering the aquifer. There are places where the surface coating is very thin or almost absent, the exposed surface of the aquifer increases the possibility of water pollution when exposed to the surrounding environment.

Climate: The study area is located in the delta of North area with the tropical monsoon. The climate is divided into two distinct seasons: rainy season from May to October and dry season from November to April the following year. The amount of water added depends on the amount of vaporization and rainfall. The amount of rainwater added to the aquifer through the fractured zone of rocky soil. Rainfall plays an important role in the supply of water to underground aquifer. The area has steep slopes and it's difficult for rainwater to drench into the aquifers, but due to the heavy rainfall and it prolonged many months of the rainy season, the total amount of water infiltrated into the soil is remarkable. Additional amounts can be determined by the formula:

$$Q = \propto FW$$

For: α is the coefficient of infiltration, F is the area of the distribution of the aquifer and W is the rainfall.

Air temperature: According to the combined data for hydrometeorology from 2007 to 2017, the highest regional air temperature was 38.9°C and the lowest was 7.3°C, annual average is 23.46°C. Air temperature affects groundwater through indirect factors - the amount of vaporization and dispersion of water steam from creatures.

Hydrological and hydrogeological conditions

+ Hydrography: River streams supply water to the aquifer when it is hydraulically linked to groundwater. At

that time, river water will provide groundwater with a quantity of water during the flood season and vice versa, groundwater will provide water to the river in the dry season. In the study area, there are no large rivers flowing through but mainly small streams, so the supply is not large. Most notably, the stream flows through the contiguous area between the plain and the limestone mountains and the Day River at the edge of the plain. So if the area has many rivers and streams, the river water will supply to the groundwater or vice versa.

+ Hydrological geology: The aquifers in the study area have a hydraulic relationship with surface water. The main source of water for the aquifer is rainwater on the permeable surface. In this area, terrain with very thin surface cover or where there is no surface pollution, the potential for contamination of groundwater is very high.

Artificial elements

- Industrial activities: The industries in this area are mainly mining, cement manufacturing ... They have seriously affected the groundwater in the area. In the study area there are many mines and many cement factories. Mineral mining destroys the natural structure of the area, disrupting the aquifers. On the other hand, mining also makes the water polluted by heavy metals, increases turbidity, hardness to groundwater.

Solid wastes, wastewater from industrial parks, factories which are not properly treated and discharged into the environment can generate pollutants and wastewater from landfills that is not hygienic is also a cause to groundwater contamination. These pollutants will land on the ground, going through groundwater transportation that pollutes the water in the area. Or they can also cause pollution to surface water which can pollute groundwater in the area.

+ Waste gas, dust from rock mining, cement manufacturing... when released into the environment, encountered rainy conditions will be merged into rainwater, falling to the soil, permeating through the soil layer, leasing to surface water thereby polluting groundwater of the area.

Water exploitation activities in the area: According to the statistics of Ha Nam Department of Natural Resources and Environment, by 2016, there are 94,000 underground water supply projects in the province, of which 50,800 hand drills with a depth of exploitation ranging from 8m - 64m, most of these projects have a capacity of 0.5 to $2m^3$/ day for some households. These projects have the advantage of being easy to invest and develop fast, but there are some basic constraints due to the spontaneous development, which makes it easy to pollute groundwater. According to the latest statistics of the Department of Mineral and Water Resources of the Department of Natural Resources and Environment, most of the wells exploited are already infected with arsenic.

Karst aquifer currently has many mining units with various types of projects, such as Number One company, which currently has 21 wells with a capacity of $2.99m^3$/ day, Ha Nam Tan Phat Limited Company has 7 wells with a capacity of $1,500m^3$/ day. Cement companies, households are also exploiting the aquifers making the management difficult to control.

Population and urban development:

+ The increase in population in the area can increase the amount of pollutants discharging into the environment that affect the groundwater. Dumps, sources of discharge will contaminate the water source if not being properly treated and managed.

+ Population growth may also increase the demand for water, which in turn leads to a decline in the groundwater reserves of the area. The amount of water used is great so exploitation will cause more risk of exhaustion and water pollution. Increasing drilling holes affect water reserves.

Other human activities:

+ Agricultural and forestry activities increase the residue of pesticides and chemical fertilizer and then contaminate the aquifers. Plant protection chemicals and excess fertilizer will directly seep down to pollute the aquifers.

+ Construction activities: Natural and artificial lakes are filled to make way for factories and schools ... so there is no artificial replenishment of groundwater.

+ Water which leaks from landfills located on the surface of the surface and there is no treatment system, the platelets penetrates directly into the groundwater.

Daily waste water discharged directly into the environment also affects the aquifer. Some emission figures of the units in the area are as follows: Hoang Long Cement Joint Stock Company - 70 m^3/ day, Thanh Liêm Cement JSC - 500m^3 / day; Sai Gon - Phu Ly Brewery JSC - 620 m^3 / day, Vissai CPM Company 3 - 26 m^3 / day, Ha Nam Number One Limited Company - 4800 m^3 / day ... Waste water is also an important pollutant to pollute the groundwater in the area.

3.2. Solutions to exploit and use reasonably and sustainably protect the aquifer

Technical solution

- The Karst aquifer has a thin surface covering, which is sensitive to sources of contamination. As a result, the protection zone has been strengthened and constructed in various forms. Waste water must be treated before disposing in the designated area, avoiding direct seepage into underground water.

- Planting green trees in the bare land to increase the landscape, increase the filtering capacity of the soil.

- Using barriers to limit the spread of dust in the mining areas.

- Constructing the bioremediation systems using trees to treat waste water.

For households living in the area, dungz treatment should be done by composting, biogas and rational collection. Domestic waste should be collected for treatment to avoid environmental pollution and water sources. Pesticide packaging, bio-preparations, waste oil and other toxic chemicals should also be collected.

- Constructing observation stations in the industrial parks, burial sites, thin coatings ... Early detection and troubleshooting.

Exploiting and using water properly, saving fresh water: To Karst aquifer, don't issue a license for small mining projects, especially boreholes with low capacity because they have low efficiency but the high risk of

environmental pollution. Licensing is only permitted with large boreholes that are exploited centrally to facilitate supervising, monitoring and forecasting. For large exploitation constructions (bore diameters of 168mm and above), it should be exploited at the depths of 25 to 75m where there is more cracked soil, has good storage and drainage. At other depths, soil and rock are less cracked so the water containing capacity is lower.

Management solution

- Apply legal documents such as laws, decrees and circulars to guide and protect underground water resources in the area.

- Monitor periodically and supervisor water resources. Carry out the management, close inspection of the drilling units, water exploitation units ... ..

+ Compile exploitation records of works for management, licensing and prohibition.

Apply new production technologies to management, exploitation and use to minimize pollution and save water.

- Plan the exploitation to avoid depletion, subsidence and pollution caused by mining.

- Apply economic tools to penalize, encourage and formulate beneficial projects, ensure water supply and hygiene. Strengthen the communication and education to raise awareness and understanding of all subjects.

Conclusion

The aquifer in the hard rock formations in the southwest area of Ha Nam province is a valuable water layer that can be exploited to meet the needs of life. However, this aquifer is being affected by many positive and negative factors: the effect of terrain, natural conditions and the amount of water added to the aquifer is clear and continuous.

- To protect the Karst aquifer for long-term, sustainable exploitation, it is necessary to delineate the mining area, prohibit small and odd exploitation projects. The exploitation of water in the aquifer should be used in concentrated exploitation projects with medium to large construction flow to control and protect the aquifers.

Manage waste sources (waste, sewage, waste gas) polluting water sources and strictly manage and severely treat the cases of polluting the water environment.

- Mineral exploitation activities in the southwest region of Ha Nam province are complicated and have bad impacts on the water resources in the aquifer. Therefore, there must be strong management measures of the government.

- The solutions to exploit and save water environment mentioned above are appropriate and should be taken seriously to protect the valuable water resources in the area.

REFERENCES

1. Do Van Binh (2013), "Management and Development of Water Resource". Lecture, University of Mining and Geology.

2. Do Van Binh (2014), "The impact of mining on the water environment of Kien Khe area, Ha Nam". Scientific workshop of the clubs of Technical Universities in the North of Vietnam.

3. Đỗ Văn Bình (2016) và nnk, "Đề án thăm dò nước dưới đất phục vụ nhà máy bia Phủ Lý-Hà Nam công suất 1500m^3/ng".

4. Do Van Binh (2016) and nnk, "Project of underground water exploration for Phu Ly-Ha Nam brewery factory with a capacity of 1500 m^3 / day".

5. Doan Van Canh et al. (2000), "Reports on natural resources and environment of groundwater in Ha Nam province", Final Report of the Survey, Investigation and Overall Planning Project of Water Supply and Rural Environmental Sanitation in Ha Nam from 1998 to 2000. Save in Water and Environment Sanitation Center of Ha Nam province.

6. Kieu Van The (2015), Report on groundwater exploration in Kien Khe area, Thanh Liem, Ha Nam.

7. Pham Kien Quoc (2002), "Study on the distribution and origin of arsenic in Holocene aquifer in Ha Nam - Propose mitigation and treatment solutions", Master of science thesis, - University of Mining and Geology.