SEASONAL VARIATION OF GROUNDWATER LEVEL AND QUALITY IN XUAN MAI, HANOI, VIETNAM

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SUMMARY

Groundwater is the crucial source for domestic, agriculture, production in Xuan Mai town. To examine the seasonal variation of groundwater level and quality, four drill well was used to measure groundwater level in February and March 2017 (dry season) and from October 2018 to October 2019 (dry season 2018, dry season 2019 and wet season 2019). Otherwise, 12 drill well used to check groundwater quality from 2017 to April 2019. The groundwater quality was analyzed according to some indicators like pH, Fe, NO_2^-, NH_4^+, NO_3^-, $CaCO_3$, TDS, Mn^{2+}, Cl-, Asen. Groundwater quality index (GWQI) method also used to calculate pollution level. The quality results has compared with QCVN 09: 2015/BTNMT. The main results of this research include: (1) Groundwater depth experienced a fluctuation trend between two seasons which dry seasons was lower than wet ones by 10.67 %; (2) Pollution was detected in some parameters like NH_4^+ and Mn^{2+} of drill well 3 in both seasons in 2017 and 2019, which exceed 12 times and 1.3 times, respectively. In rainy season 2019, there was 2 more polluted indicators NO_3^- and Cl^- in drill well 5, 6, 12; (3) According to groundwater quality index, the groundwater of drill well 3 was very poor in 2 seasons due to discharge from the factory in this area. The study provides specific information, a useful tool monitoring data of groundwater quality research to help authorities in planning appropriate strategies for sustainable management of groundwater resources.

Keywords: Groundwater, groundwater depth, groundwater quality index, seasonal variation.

1. INTRODUCTION

Water accounts for three-fourths of the earth's surface and it is also an extremely important resource in human life (Jayanta, 1987). However, the source of fresh water, especially groundwater, used in daily life is not infinite (Jayanta, 1987; Gökçe, 2016). Groundwater plays a necessary role in human life, it has long been emphasized as the most important water source because it accounts for more than 70% of total water consumption (Timmerman, 1999; Willms, 1998). Besides, groundwater contribute an important part in agricultural and industrial activities (Quynh, 2019). It is used not only for current purposes but also as a potential source of water for future consumption (Jinwal, 2018).

Currently, groundwater resources are being degraded at alarming rate in both quantity and quality in many locations (Jacob, 2009). About 70% of total groundwater is used for agriculture but more than half of this is not absorbed by crops because of leakage and evaporation (Johnson, 2001). In addition, as the population increases, we will rely more on irrigation for our food supply to put stress on underground water systems, especially in arid and semi-arid areas (Johnson, 2001; Jayanta, 1987). The high demand for water for industrial and agricultural development leads to significant depletion of groundwater (Hien, 2018). Previous studies have concluded that domestic waste and sewage from manufacturing activities are the main source of contaminated groundwater (Hien, 2018; William, 1999).

In Vietnam, the quality and quantity of groundwater are at risk. Pollution and groundwater degradation locations are usually in large cities or industrial areas with high population densities and fast economic growth. Hanoi is one of the biggest cities in Vietnam, which is densely populated and has a large number of industrial plants. Hanoi currently has 16 groundwater exploitation factories and 15 water production stations with a total of 302 drill-wells are being exploited, with a total flow of about 718,200 m^3/day to supply water for domestic use and production (MORE report, 2016). The widespread exploitation of groundwater in the shallow layer is a cause leading to the decline in the quality of underground water in deeper layers, greatly affecting the sustainable development of water resources in Hanoi. Xuan Mai - a suburban town in Hanoi is also in the process of industrialization - modernization, is a crowded residential area. The water used by people is mainly groundwater. However, in some recent years, in dry season, falling groundwater quickly lead to water shortages in some areas. Therefore, the analysis and evaluation of the water depth and groundwater quality in this area are essential for the development of sustainable groundwater use and management. The main goal of this study is to determine the seasonal changes in groundwater level and quality in Xuan Mai, Hanoi, Vietnam. This study provides a scientific and practical basis for analyzing groundwater variation and water quality in different season and some solutions for the proper use of this valuable resource.

2. RESEARCH METHODOLOGY

- Study site

Xuan Mai town which is located approximately 33 km west of the capital Hanoi, between 28°58' North latitude, 105°05' East longitude east longitude, belongs to Chuong My district, Hanoi (Fig. 1). The study location lies on the intersection between National Highway 6A and National Highway 21A covers by 1051.88 hectares. The characteristic in this location is semi-mountainous and uneven, with mountainous terrain low and is transitional place between the plain and the midland with relatively high elevation.

The study area has a tropical monsoon climate, characterized by distinct seasons: the rainy season starts from April to October and the dry season starts from November to March of the following year. The average temperature is 22.5°C, while the average humidity and average annual precipitation is 75% and 1839 mm, respectively. The soil in this area is defined as yellowish-brown ferralsols, develops on the maternal rock poocfiarite belonging to the neutral magma group. With a population of 27,000 people, the majority of citizens have used underground water for living and production activities with mainly a canal system which is Bui River, Tich River that contribute to irrigation and water supply for the needs of production from factory and agriculture of people.

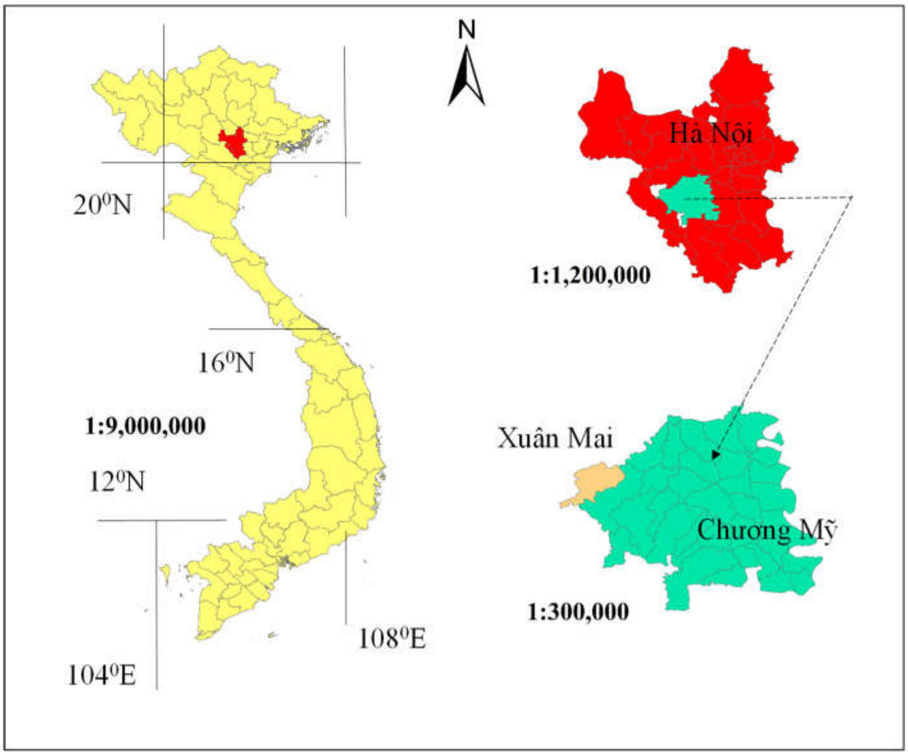

Figure 1. Map of study location

- Evaluating seasonal variation of groundwater level (depth) in Xuan Mai

To evaluate seasonal variation of groundwater level, 4 drill-wells was measured from the ground surface by using a Rugget Water Level Tape (Fig. 2a; Fig. 3) one time per week. Time monitoring was from February to April, 2017 at drill well 3, 10, 11 and from October 2018 to October 2019 at drill well 12. The groundwater level was collected by dropping head of measuring coil to the well until we hear the beep sound from the coil. The number to read was the length from the ground until the beep sounds (Fig. 2b). In addition, the fluctuation of groundwater depth was drew in Excel software and SPSS 23 for spatial change.

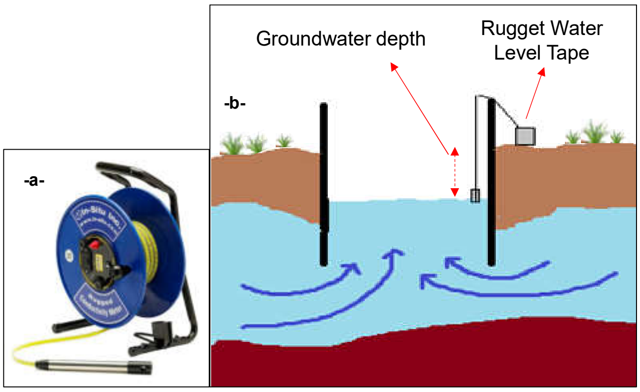

Figure 2. (a) Picture of Rugget Water Level Tape; (b) Illutrating picture of goundwater depth measurement

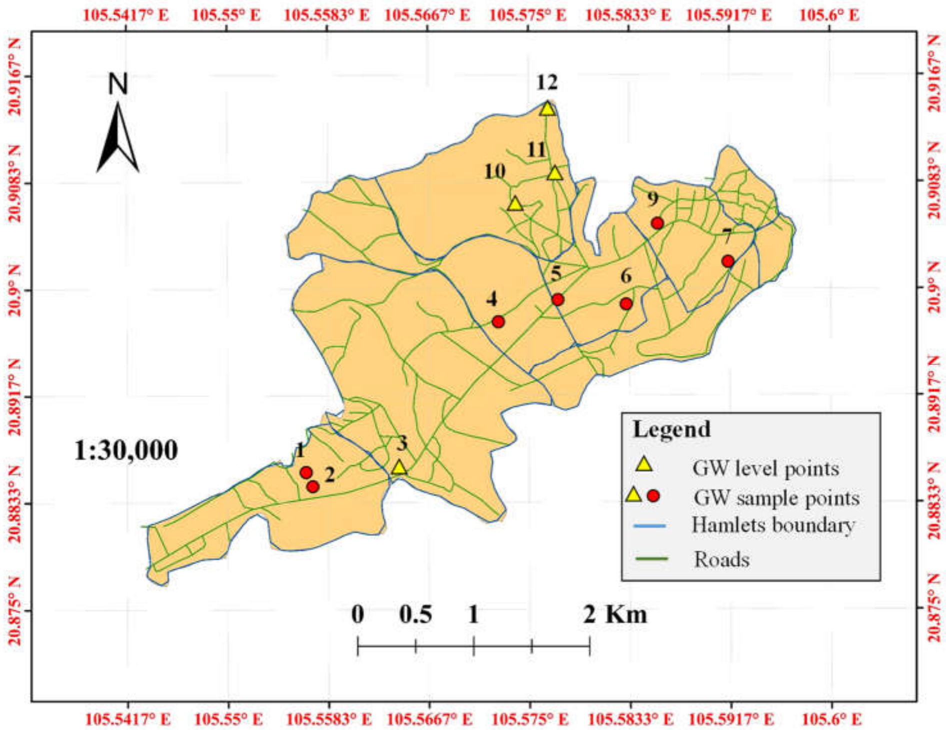

Figure 3. Map of groundwater depth measurement and groundwater quality samples

- Examining seasonal variation of groundwater quality

The total of groundwater quality samples is 90, in which 8 samples were collected one time in April, 2017 (dry season); 11 samples were taken two times from March 2019 to April 2019 and 12 samples were gathered 5 times between May to September 2019 (Fig. 3). Sample bottles were cleaned by rinsing them with distilled water. The water samples were collected after pumping for 10 to 15 minutes in order to remove stagnant groundwater. Taking samples with water at least 3 times to ensure that no external impurities in the sample, then carrying out sampling. And then, samples were transported to the laboratory in the shortest time and were kept in a dark place and stored at 2 - 5°C by ice to avoid contamination and discoloration. Chemicals used for preservation should be pure to minimize errors in analysis. In particular, the following criteria were monitored: pH, Fe, NO_2^-, NH_4^+, NO_3^-, $CaCO_3$, TDS, Mn^{2+}, Cl^-, Asen (Table 1). The result analyzed from laboratory then would be compared with the Vietnam standard 09: 2015/Ministry of Natural Resources and Environment (QCVN 09: 2015/BTNMT) to define whether it is out of threshold or not.

Table 1. Method to analyze the indicators in laboratory

TT	Parameters	Methods
1	**pH**	TCVN 6492:2011 (ISO 10523:2008)
2	**Fe**	TCVN 6177:1996 (ISO 6332:1988) - spectrometric method using reagent 1,10 – phenantrolin
3	**NO^-_2**	TCVN 6178:1996 (ISO 6777:1984). Molecular absorption spectrometry method
4	**NH4+**	TCVN 6179-1:1996. Manual spectrometer method.
5	**NO^-_3**	TCVN 7323-1:2004 (ISO 7890-1:1986. Spectrometric method using 2,6-dimethylphenol.
6	**$CaCO_3$**	SMEWW 2340.B:2012.
7	**TDS**	SMEWW 2540.C:2012
8	**Mn^{2+}**	TCVN 6002:1995 (ISO 6333:1986). Photometric method with fomaldoxime
9	**Cl^-**	TCVN 6194:1996
10	**As**	TCVN 6626:2000 (ISO 11969:1996. Atomic absorption method (hydride technique).

Note: *TCVN mean Vietnam standard; ISO mean International Organization for Standardization; SMEWW mean Standard Methods for the Examination of Water and Waste Water.*

- Ground Water Quality Index

The groundwater quality index (GWQI) method reflects the effect of specific water quality parameters, depending on the characteristics of the study area and the purpose of use (Au et al., 2001). Particularly for groundwater, from the criteria, the study conducted to calculate the water quality index of WQI by the formula (Vasanthavigar et al., 2010):

$$\boldsymbol{Wi} = \frac{\boldsymbol{wi}}{\sum \boldsymbol{wi}} \qquad (1)$$

Where:

wi: weight of each parameters

Wi: relative weight values

$$\boldsymbol{GWQI} = \sum_{i=1}^{n} \boldsymbol{SIi} \quad (2)$$

$$SI = Wi \; x \; qi \qquad (3)$$

$$qi = \frac{Ci}{Si} \; x \; 100 \qquad (4)$$

Where: WQI: Water quality index;

qi: The quality rating;

Ci: Concentration of indicator;

Si: Permitted level of TCVN09:2015/BTNMT.

Table 2. Indicators to calculate GWQI index

Indicators	Unit	Weight (w_i)	QCVN 09:2015/BTNMT	QCVN 02:2015/BYT	Analysis time
pH		3	8,.5	8.5	03/2017, 03-09/2019
Fe	mg/l	5	5	0.5	
NO_2^-	mg/l	5	1	-	
NH_4^+		5	1	3	
NO_3	mg/l	5	15	-	
$CaCO_3$	mg/l	3	500	350	
TDS	mg/l	4	1500	-	
Mn^{2+}	mg/l	5	0.5	-	
Cl^-	mg/l	4	250	300	05-09/2019
Asen	mg/l	-	0.05	0.05	06/2019, 08/2019

After calculate WQI of groundwater, it was compared with the standard to conclude the current status:

Table 3. Status of Water Quality based on WQI (Au NH, 2018)

WQI range	Status
< 20	Excellent
20 - 50	Good
50 - 100	Poor
100 -200	Very Poor
> 200	Unfit For Drinking

The results of sample analysis were interpolated by IDW method for the whole area on ArcGIS 10.4 software. The formula is:

$$\mathbf{Z(S_o)} = \frac{\sum_{i=0}^{n} Z(Si)\,\lambda i}{\sum_{i=1}^{n}(\lambda i)} \quad \text{(Theobald, 2009)}$$

In which:

$Z(S_o)$: The value of the i^{th} point;

S_o: The position to be interpolated;

n: The number of known points within a certain distance from the position to be interpolated.

λi is the weight of i^{th} point: $\lambda i = 1/d_i^P$ (d_i is the distance between point I and S_o, P is the exponent of the distance).

3. RESULTS AND DISCUSSION

a. Seasonal variation of groundwater level (depth)

The groundwater depth was difference between four drill wells range from 1.1 m to 12.9 m. The drill-well 12 had the highest average groundwater depth at 10.6 m, the depth of 3 remaining drill wells were much lower such as about 2.6 m of the drill wells 10, 11 and lowest at 2.47 m of drill well 3 (Fig. 4). The groundwater levels fluctuate due to factors of exploitation and use of people even according to space and topography. The depth of groundwater increases following by elevation, the higher altitude is increasing groundwater level (Fig. 4). Luot mountain (drill well 12) has elevation about 35 m above sea level while the drill well 10 – Chien Thang residential house, the elevation is 16 m. In addition, the forests and natural topographic and rainfall also affect to the groundwater depth. The forest far away, the groundwater is lower the closer to the forest the groundwater depth tends to rise.

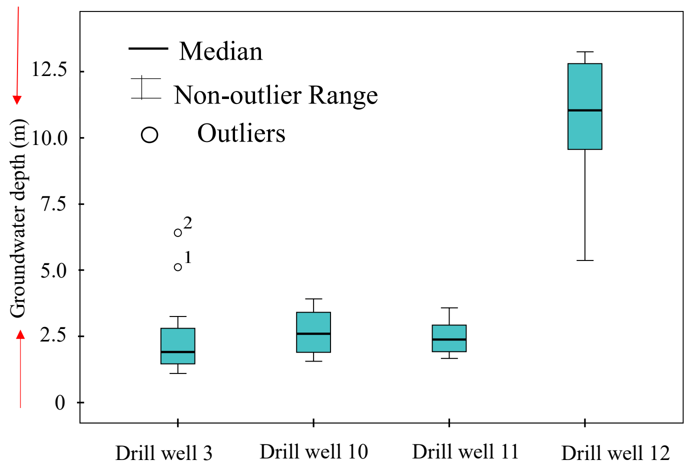

Figure 4. Spatial change of groundwater depth

The seasonal variation of groundwater depth is difference at four drill wells. For drill well 3, the average groundwater depth is at 2.84 m in dry season and 1.75 m in wet season, difference 38.34%, while drill well 12 has lowest difference between dry and wet season at 7.12 %. In drill well 3, the dry season in March 2017, the groundwater level which is 6.8 m, March-2019, rose 3.5 m in the groundwater depth before significantly increasing at 1.56 m in wet season in August – 2019 due to 846.4 mm precipitation (Fig. 5 a,b). For drill well 10, the depth of groundwater in three dry month in 2018 has the same level about 3.5 m (Fig. 5c). Then, the level of groundwater kept the sharply increase with the highest level in August about

1.4 m in rainy season (Fig. 5d). This rule is also unchanged in 2017 and 2018, the rainy months have rose groundwater depth compared to the month without rain. The groundwater depth of drill well 11 in some rainy months is still lower than in non-rainy months (Fig 5. e, f). As in October 2018, rainfall measured 93.6 mm, the groundwater level measured this month was 2.24 m (Fig. 5e), but in the dry months of 2019, the water level is deeper, in March 2019 at 3.58 m (Fig. 5e). The highest groundwater depth in June is 1.66 m although rainfall in this month is lower than August 2019 (Fig. 5f). For drill well 12, in dry season, the level of groundwater was the highest level at 5.7 m in Oct 2018 which dramatically decline to 13.7 m in March 2019 (Fig. 5g) although the precipitation was higher. During wet season, groundwater depth also remain lower level compared with dry season 2018 and 2 first month 2019 with the deepest in August about 9.8 m (Fig. 5h).

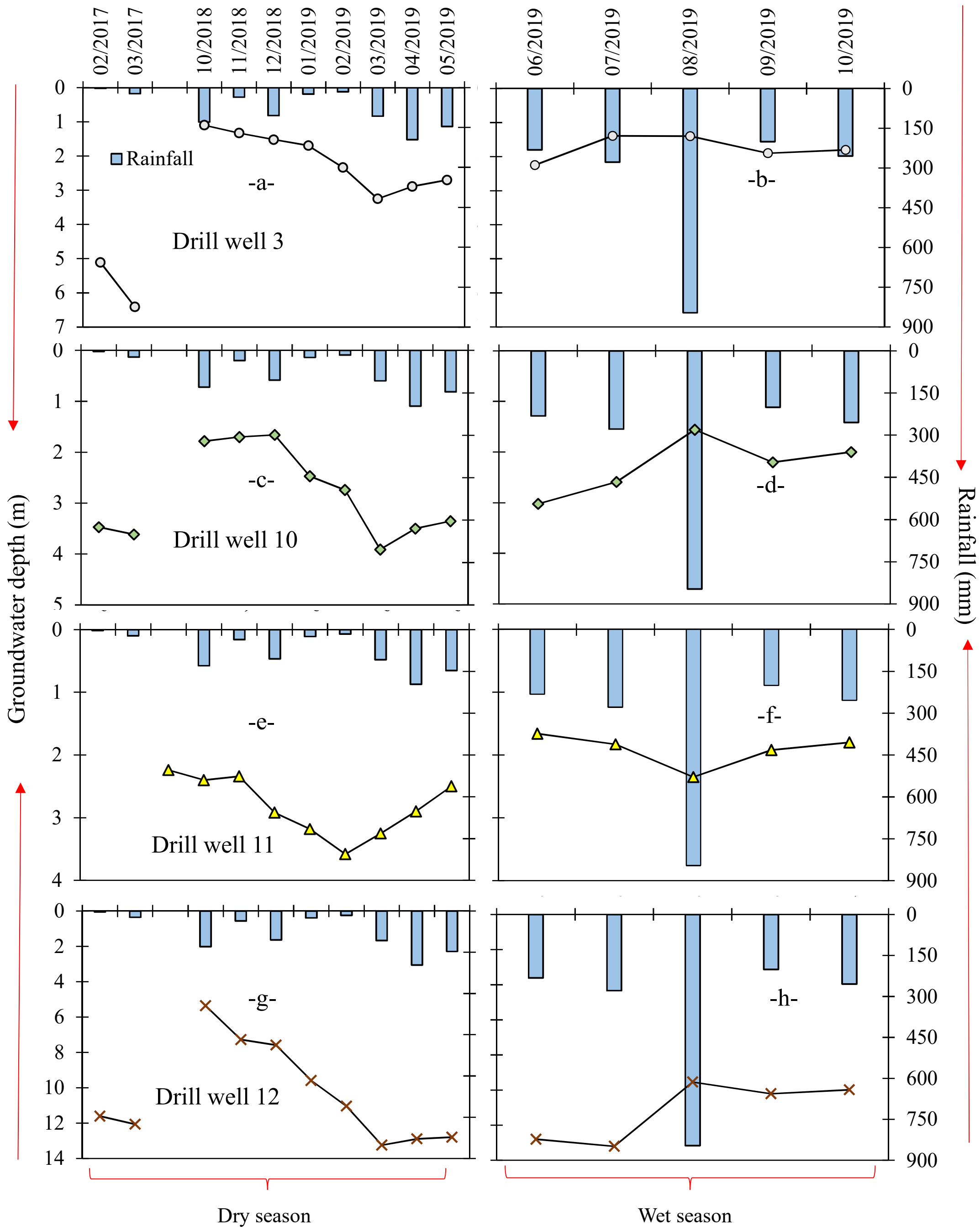

Figure 5. The fluctuation of groundwater depth between dry and wet seasons: (a, b) Drill well 3; (c, d) Drill well 10; (e, f) Drill well 11; (g, h) Drill well 12

When monitoring in the field at four drill well, the groundwater depth witnessed the change between two season which were increasing in dry season and decreasing in wet season. The main reason causes the fluctuation may be precipitation. Monthly rainfall of dry season ranged from 3.4 mm to 146.8 mm and from 200.9 mm to 856.3 mm of wet season. Moreover, the other reason is affected not only rainy and sunny weather but also human exploitation and use factors. Drill well 11 provide water for all activities of students and households living around the Vietnam National University of Forestry so July is the summer holiday for students and the demand for water decreases because the amount of groundwater exploitation decreases, leading to an approximately decrease in groundwater depth. Although influencing by temperature and rainfall, the groundwater is not infiltrate immediately, it takes 3 or 4 days later for this. On the other hand, drill well 12 located in mountainous topography, covered by vegetation and plants so the vegetation also affects the groundwater, the thicker the vegetative cover, the slower the evaporation capacity, the greater the water holding capacity, and the smaller the surface flow. Vegetation cover plays an important role in controlling the regulation of groundwater level, increasing soil moisture, thereby reducing evaporation of the soil surface.

b. Seasonal variation of groundwater quality at the study site

- *Groundwater quality variation between dry seasons of 2017 and 2019*

In general, the quality of groundwater in the wells varies with the dry seasons between two years. While the concentrations of pH, Fe_3^+, NO_2^-, NH_4^+, $CaCO_3$, TDS increased between the two dry seasons, NO_3^- and Mn^{2+} witnessed a slight decrease. Although the indicators of pH, Fe^{3+}, NO_2, $CaCO_3$, TDS, NO_3^- still fluctuated, they were still within the permitted threshold of QCVN 09: 2015 BTNMT. However, the concentration of NO_3^- and TDS increased sharply at wells 3, 5, 6, 9, 10 that are close to the allowed threshold may also cause harm to people's health (Table 4).

Table 4. Characteristics of groundwater quality at the study site

	Dry season 2017				Dry season 2019				Wet season 2019				QCVN 09:2015/ BTNMT
	Mean	Max	Min	Sd	Mean	Max	Min	Sd	Mean	Max	Min	Sd	
pH	6.5	6.9	6.1	0.249	6.8	8	5.2	0.634	6.8	8.1	5.7	0.442	8.5
Fe3+	0.121	0.273	0.025	0.100	0.205	0.800	0.000	0.190	0.348	4.908	0.000	0.836	5
NO2-	0.007	0.037	0.001	0.012	0.062	0.380	0.002	0.084	0.062	0.401	0.000	0.080	1
NH4+	0.172	0.548	0.018	0.198	0.843	6.474	0.000	1.583	**1.122**	**16.086**	**0.000**	**2.480**	1
NO3-	1.833	3.861	0.145	1.178	1.500	12.044	0.000	2.709	3.817	22.830	0.031	4.290	15
CaCO3	126.4	230.0	42.0	70.1	131.4	234.0	8.0	71.3	171.4	320.0	48.0	58.0	500
TDS	130.0	290.0	40.0	76.0	243.7	1207.0	19.0	282.5	219.1	516.0	63.9	95.2	1500
Mn2+	0.480	1.048	0.101	0.381	0.111	1.653	0.000	0.373	0.151	1.319	0.000	0.247	0.5
Cl-					20.38	94.30	10.64	27.69	82.87	257.01	10.64	49.97	250

In addition, there are 2 indicators NH_4^+ and Mn^{2+} exceeds permitted standards of the Ministry of Natural Resources and Environment (MONRE). During the 2017 dry season, no well was contaminated with NH_4^+, the average NH_4^+ concentration of the wells was at 0.172 mg/l. The highest at well 8 is 0.548 mg/l, half of the standard (Fig. 6a; 7a). However, by 2019, NH_4^+ concentration will increase dramatically. There are 8 out of 12 wells with NH_4^+ concentration exceeding the standard. Well 3 has the highest NH_4^+ concentration in May 2019 with a concentration of 6,474 mg/l, which was about 6.5 times higher than the norm of MONRE, 2.5 times that of the Ministry of Health (MOH) and 12 times that in 2017 (Fig. 6a; 7b). April 2019 is the time when NH_4^+ pollution is the most serious. 8 wells in April had a sudden increased the NH_4^+ concentration, causing the total number of polluted wells in April to surpassed that in March by 7 (Fig. 6a; 7b). Regarding the Mn^{2+} indicator, in the 2017 dry season, there were 3 wells (3, 7, 8) with the concentration exceeding the allowed level. In which, well 3 has the highest concentration of Mn^{2+} of 1,048 mg/l, twice the norm of the MORNE (Fig. 6b; 7d). During the dry season of 2019, although the average Mn^{2+} concentration of wells decreased, there were still 3 wells contaminated with manganese, wells 3, 4, and 11. Well 3 with the highest Mn^{2+} concentration in March 2019 was 1,653 mg/l, was 1.5 times the safe level. In April and May 2019, Mn^{2+} concentrations decreased in all wells. Until May 2019, none of the wells were contaminated with manganese, but the Mn^{2+} concentration in wells 2 and 3 was still high (Fig. 6b; 7e).

In summary, between the dry season 2017 and 2019, groundwater quality tends to worsen especially the two indicators NH_4^+ and Mn^{2+}. Water quality varies not only by time (dry season of 2 years) but also by space (among wells). According to the parameters we can see that the water quality in well 3 is the worst in the area (Table 4).

- *Groundwater quality variation between dry and wet seasons of 2019*

Water quality fluctuated according to wet and dry seasons. In general, water quality in rainy season is worse than that in dry season. Most of the indicators witnessed an increase in concentration except for constant trend of NO_2^- and a negligible reduction of TDS. The concentration of Fe_3^+ increased but still was within the permitted level. Concentrations of NO_3^- and Cl^- in the dry season in 2019 are both low and within the safe threshold but in the rainy season 2019, NO_3^- of wells 5, 12 and Cl^- of well 6 exceed the permitted level of MONRE. The remaining wells do not exceed the threshold level but quite high (Tab. 4).

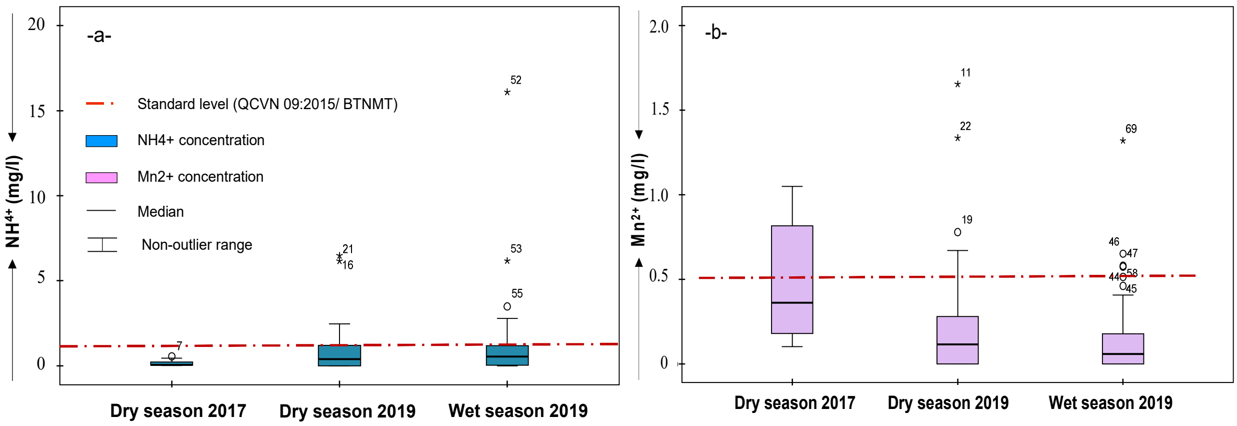

Figure 6. Box plot of (a) NH_4^+ concentration between the dry and wet seasons; (b) Mn^{2+} concentration between the dry and wet seasons

In addition, the concentration of NH_4^+ and Mn^{2+} exceed the permitted standards according to QCVN 09: 2015/BTNMT. NH_4^+ concentration in rainy season in 2019 increased significantly. The highest NH_4^+ concentration in June 2019 was 16,086 mg/l with 12 time higher of permited threshold (Fig. 6a; 7c). In August of 2019, NH_4^+ concentrations began to decrease but still remained high. In September 2019, NH_4^+ in all wells increased with the concentration exceeding the permitted standard. The average NH_4^+ concentration of the wells is 1,122 mg/l, which was 1.3 times higher than one of the dry season in 2019 (Tab. 4; Fig. 6a). The Mn^{2+} indicator fluctuated between the rainy and dry seasons in 2019. The average concentration of Mn^{2+} in the rainy season of 2019 was 1,151 mg/l, which is higher than the dry season by 0.04 mg/l (Tab. 4). The number of manganese contaminated wells in the wet season has added 1. The highest concentration of Mn^{2+} in the wet season is 1.32 mg/l, was 2.6 times the norm. Wells 3, 4, 11 are contaminated with manganese in the dry season, while wells 1, 2, 3 and 4 are contaminated in the rainy season. Although Mn^{2+} concentration of well 11 has dropped below safe level, it was still high (Fig. 6b; 7f).

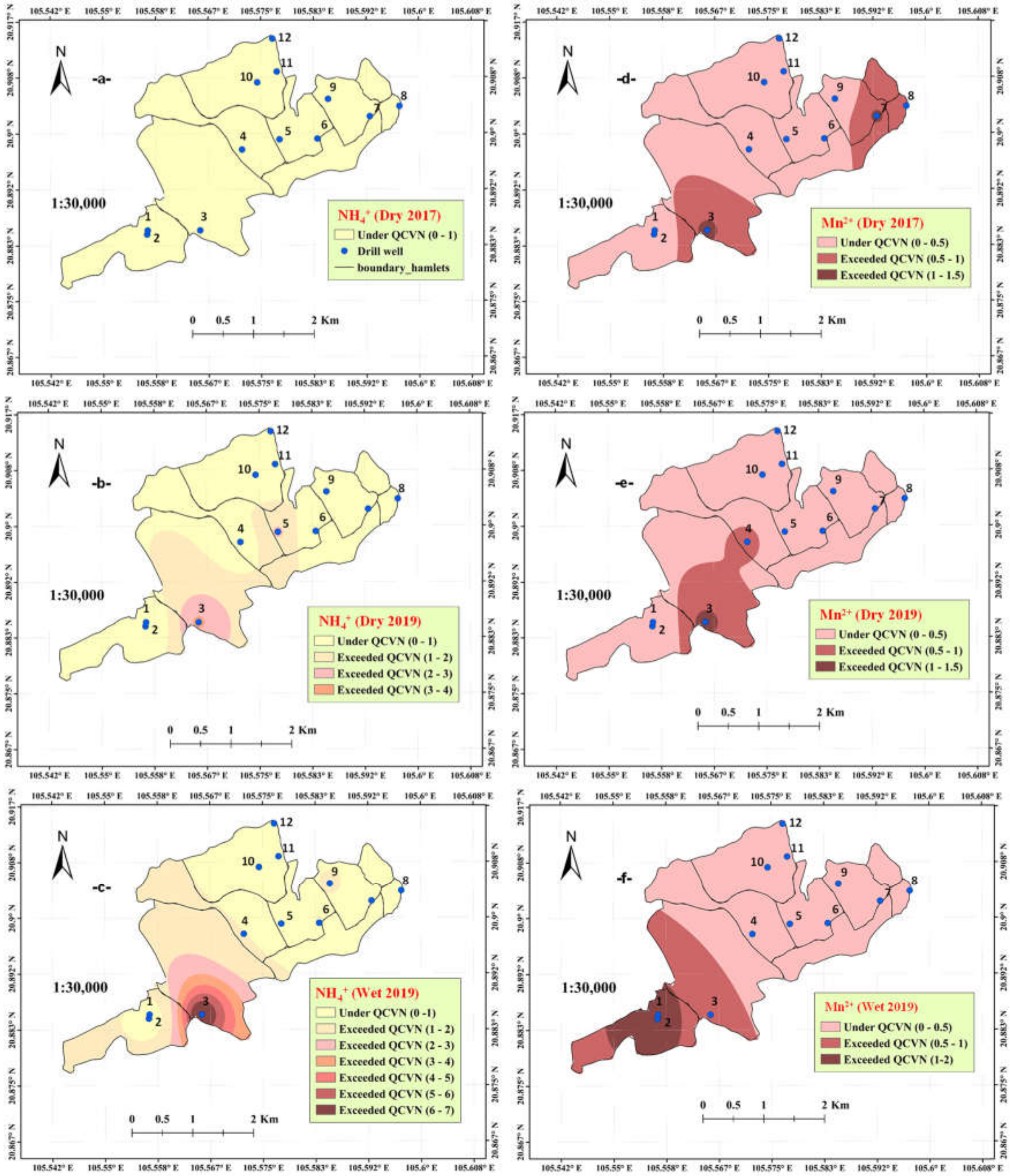

Figure 7. Interpolation map of (a) NH_4^+ in dry season 2017; (b) NH_4^+ in dry season 2019; (c) NH_4^+ in wet season 2019; (d) Mn^{2+} in dry season 2017; (e) Mn^{2+} in dry season 2019; (f) Mn^{2+} in wet season 2019

c. Assess and interpolate groundwater quality according to GWQI

GWQI is calculated for the dry and rainy season in 2019. It can be seen that the quality of groundwater for the rainy season in 2019 is lower than that in the dry season. While there were 9 wells in the dry season with GWQI < 20 (very good quality), there are no wells in the rainy season got “Very good” quality. Well 3 is the most polluted well with poor quality. The highest GWQI of well 3 is 254.98, reached the “Very poor” quality. In the rainy season in 2019, the well 3 has an average GWQI of 122.91, exceeding the dry season by 12.49 units (Table 5). Therefore, the groundwater in this area is not suitable for drinking because they will bring many potential dangers. However, because of no treatment and measures to replace groundwater in domestic activities, local people still have to use polluted groundwater for daily life.

Table 5. GWQI characteristics for groundwater quality in each drill-wells

Drill-well	Dry season 2019		Wet season 2019					
	Mean	**Quality**	**Mean**	**Max**	**Min**	**Med**	**Sd**	**Quality**
1	13.09	Very good	25.48	32.16	15.60	27.08	8.05	Good
2	32.18	Good	39.13	61.87	25.91	34.37	15.74	Good
3	**110.42**	**Poor**	**122.91**	**254.98**	**50.67**	**93.00**	**92.31**	**Poor**
4	16.51	Very good	37.70	43.49	32.79	37.25	5.39	Good
5	15.93	Very good	29.09	59.98	17.74	19.31	20.61	Good
6	18.86	Very good	23.76	42.58	15.63	18.41	12.80	Good
7	13.08	Very good	22.71	33.72	16.20	20.45	7.99	Good
8	16.86	Very good	22.17	29.38	15.84	21.73	6.25	Good
9	20.19	Good	33.85	51.24	19.93	32.11	15.87	Good
10	15.35	Very good	23.52	42.01	11.91	20.09	12.96	Good
11	10.58	Very good	28.27	43.51	17.18	26.20	11.23	Good
12	13.26	Very good	34.37	63.01	19.74	27.36	19.74	Good

Based on the interpolation map of groundwater quality according to the GWQI index in Xuan Mai, the Southern Region (Well 3) has the worst water quality in the whole region. The more you move to the Northeast, the better the water quality in the dry season. However, during the rainy season, the water quality in the areas is almost uniform at the "Good" level. Comparing between the dry and rainy seasons, the water quality area at “Very good” is narrowed, the area of “Poor” water area is expanded to surrounding areas, especially the North (Fig. 7).

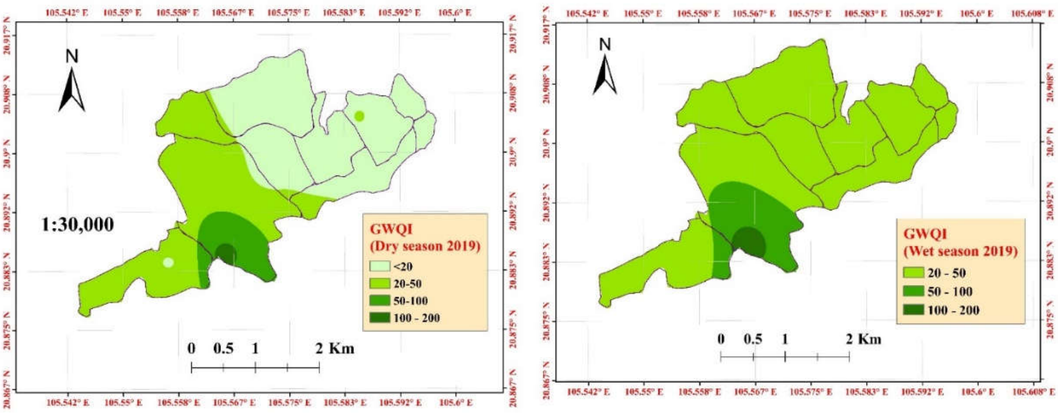

Figure 7. Interpolation map of groundwater quality according to the GWQI index

4. CONCLUSION

Based on field observation and analyzing of the groundwater depth and quality fluctuated according to the dry and wet seasons of two years such as 2017 and 2019. The research has achieved some results as follows: (1) the average depth of groundwater fluctuated from 1.4 m to 11.2 m (corresponding to 10.67%), depending on the elevation of each locations and topography. Overall, the dry season recorded the groundwater depth higher than that in rainy season especially drill well 3 and drill well 12 with 38.34% and 28.87% differences, respectively; (2) Between the dry seasons of 2017 and 2019, 6 water quality indicators increased, especially NH_4^+ and Mn^{2+}. These 2 indicators cause pollution in 10 out of 12 wells except wells 1 and 2. The highest NH_4^+ and Mn^{2+} concentrations in the dry season 2019 increased by 12 and 1.3 times that in 2019, respectively. In the rainy season in 2019, the number of NH_4^+ and Mn^{2+} contaminated wells increased by 2, meaning that all wells were polluted. In addition, in the rainy season in 2019, NO_3^- and Cl^- indicators also exceeded the allowed threshold at wells 5, 6, 12; (3) The GWQI index increased during the rainy season in 2019. Well 3 is the most polluted place to reach the "Poor" level. Especially in June 2019, GWQI of well 3 was 254.98 under the "Very poor" level. Based on the interpolation map of groundwater quality according to the GWQI index, it is possible to see that the polluted water area in the rainy season is expanded especially in the Southeast, around the area of well 3. The research results reflect the groundwater level and quality in Xuan Mai town compared between dry and wet season in 2017 and 2019, which the basis to propose solutions in order to reduce negative impacts to groundwater

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BIẾN ĐỘNG THEO MÙA CỦA MỰC NƯỚC VÀ CHẤT LƯỢNG NƯỚC NGẦM TẠI XUÂN MAI, HÀ NỘI, VIỆT NAM

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TÓM TẮT

Nước ngầm là nguồn nước thiết yếu cho sinh hoạt, nông nghiệp và sản xuất tại thị trấn Xuân Mai. Để đánh giá sự biến động theo mùa của mực nước và chất lượng nước ngầm, 4 giếng đã được dùng để đo mực nước vào tháng 02 và tháng 03 năm 2017 (mùa khô), từ tháng 10 năm 2018 đến tháng 10 năm 2019 (gồm mùa khô năm 2018, mùa khô 2019 và mùa mưa 2019). Mặt khác, 12 mũi khoan được sử dụng để kiểm tra chất lượng nước ngầm từ 2017 đến 2019. Chất lượng nước ngầm được phân tích theo các chỉ tiêu như: pH, Fe, NO_2^-, NH_4^+, NO_3^-, $CaCO_3$, TDS, Mn^{2+}, Cl-, Asen. Phương pháp chỉ số chất lượng nước ngầm (GWQI) được dùng để tính toán mức độ ô nhiễm. Kết quả chất lượng nước đồng thời được đem so sánh với QCVN 09: 2015/BTNMT. Kết quả chính của nghiên cứu là: (1) Độ sâu mực nước ngầm có sự biến động giữa hai mùa trong đó mùa khô ghi nhận độ sâu thấp hơn mùa mưa với sự chênh lệch 10,67%; (2) Sự ô nhiễm nước ngầm được phát hiện ở một số chỉ tiêu như NH_4^+ và Mn^{2+} tại giếng 3 cho cả hai mùa khô năm 2017 và 2019, lần lượt vượt ngưỡng cho phép là 12 và 1,3 lần. Vào mùa mưa 2019, có thêm hai chỉ tiêu bị ô nhiễm là NO_3^- and Cl^- ở giếng 5, 6, 12; (3) Theo chỉ số chất lượng nước ngầm, nước của giếng 3 thì "rất xấu" ở cả hai mùa do việc xả thải từ các nhà mày tại khu vực này. Nghiên cứu đã cung cấp thông tin cụ thể và một công cụ hữu ích (GWQI) nhằm giám sát chất lượng nước ngầm. Kết quả có được đồng thời giúp các cơ quan chức năng hoạch định các chiến lược phù hợp để quản lý bền vững tài nguyên nước ngầm.

Từ khóa: Biến động theo mùa, chỉ số chất lượng nước ngầm, độ sâu nước ngầm, nước ngầm.

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