OUKA
Osaka University Knowledge Archive

Title	SOME RESULTS OF GROUNDWATER QUALITY MONITORING IN VIETNAM
Author(s)	Nguyen, Thi Phuong Thao; Pham, Hung Viet; Tu, Vong Nghi et al.
Citation	Annual Report of FY 2000, The Core University Program between Japan Society for the Promotion of Science(JSPS) and National Centre for Natural Science and Technology(NCST). 2002, p. 9-14
Version Type	VoR
URL	https://hdl.handle.net/11094/12981
rights	
Note	

Osaka University Knowledge Archive : OUKA

https://ir.library.osaka-u.ac.jp/

Osaka University

SOME RESULTS OF GROUNDWATER QUALITY MONITORING IN VIETNAM

Nguyen Thi Phuong Thao[1], Pham Hung Viet, Tu Vong Nghi[2], Minoru Tanaka, Yuta Yasaka[3]

[1] *Institute of Chemistry, NCST*

[2] *Hanoi National University, HNU*

[3] *Osaka University, Japan*

ABSTRACT

Groundwater sources in Vietnam are very abundant and diversified. 22 cities and towns of the country have been exploiting and utilizing groundwater for domestic and industrial water supply by means of concentrated well fields and the "UNICEF" wells of low-cost technology. Some groundwater sources contain high concentration of iron, manganese, amonia, and organic matters, especially arsen and fluor. It is, therefore, essential to determinate groundwater quality before utilizing in order to make the best use, protection as well as management of groundwater quality and capacity.

This article presents some results of groundwater quality monitoring in Vietnam and the comparison among the analytical methods applied for the purpose.

Keywords: Arsen, Field, Groundwater, Laboratory method, Nitrate, Organic

Introduction

In Vietnam, groundwater is used much in many constructions with the ratio of about 70-80%, whereas rainwater accounts for some 20-30%; and surface water only 1%. Groundwater has been ever-increasingly utilized, representing more than 7.3 million m^3/ day; over 1.1 million m^3/day of which is of high category reserve[1]. Some 693.000 m^3/day is developed for domestic and industrial water supply. In Hanoi, groundwater is mainly found in the two aquifers of Holocen and Pleistocen in the depth of about 30-70 m^3 in most of the wells. The water is exploited in three forms:

- Concentrated exploitation

Groundwater sources with depth 60-70m are exploited by professional staffs from Fesh Clean Business companies. This form is applied in the North and the South of Vietnam with the capacity of 734.000 m^3/ day.

- Single exploitation

Offices, enterprises and military bases exploit groundwater to use. Their depths are 30-40m. The capacity of this form is about 281.000 m^3/ day.

- Exploitation through the "UNICEF" well with depth 25-40m.

This kind of wells has mostly applied in rural areas for domestic use. However, a number of urban households have used the "UNICEF" wells, too. Its capacity is about 480.000 m^3/ day.

Groundwater is clean water source for domestic supply, even for drinking. However, the contamination coming from two following reasons has make it no longer clean enough to use:

- Groundwater is polluted by such heavy metals as Hg, Fe, Mn, As and fluor mineral ores from soil sediment through which groundwater streams run.
- Groundwater pollution is caused by human activities.

In accordance with a lot of researches, groundwater quality in many areas of Vietnam is badly polluted. In Hanoi, for example, there have been indicators showing the pollution such as NH_4, NO_2, bacteria, Fe, Mn and especially Arsen; in Hai Phong, the most remarkable indicators are NO_2, Fe, Al, Hg; in Nam Dinh, NH_4, NO_2, Fe, Mn, Hg, Al; in Viet Tri and Bac Giang, NH_4, NO_2, Fe, Mn, too.

In Vietnam, many laboratories carry out the determination of contents of some groundwater parameters through many analytical methods. Within the framework of the article, the authors would like to present a number of results in addition to the information about groundwater contamination so as to make it clear some existing questions relating to groundwater quality in Vietnam and comparison among analytical results conducted by different analytical methods.

Methods

The results mentioned in the article have been achieved though collecting precious publications on groundwater quality as well as sampling and analyzing groundwater samples in Hanoi.

Apparatuses

All parameters of groundwater quality are determinated by field monitoring apparatus and Laboratory.

- *Field apparatuses:* Digital water analyzer AQUASEARCH , Model L-8030SP, Kyoritsu Chemical- Check. Lab. Corp. The Digital Water Analyzer AQUASEARCH is supported by Prof. Minoru Tanaka and CUP, JSPS program for Institute of Chemistry, NCST in 1999. The Digital Water Analyzer is used for drinking water to determinate 12 items such as Chloride, Chlorine, Free cyanide, Chromium(6+), Copper, Iron, $KmnO_4$- demand (as COD $KMnO_4$), Nitrite-N, Nitrate-N, Total Hard, Zinc.

- *Laboratory apparatuses as:*
  + Atomic absorption spectrometer AAS, Shimadzhu, Japan.
  + Spectrophotometer UV-VIS, British.
  + Others laboratory apparatuses.

Results and discussion

The present groundwater contamination has been studied in many areas in Vietnam, for example, Hanoi, Hai Phong, Nam Dinh, Viet Tri-Lam Thao, Bac Giang, Thanh Hoa, Ho Chi Minh City, Tra Vinh, etc....According to the study, the main polluted items of groundwater sources could be as follows:

Salification

Gradually lowering water level influence in general by exploiting on the pq_1 aquifer and m_4 aquifer in the South plain, on the qp2 aquifer in the North plain so that from 1996 to 2000, the lowering of groundwater level by exploitation with different velocity and clearly. For example, average lowering velocity of water in Hanoi is 0.4m/year; Ho Chi Minh City, 0.6m/year; Ca Mau, 1.0m/year; Soc Trang, 0.7m/year; and others places, about 0.2-0.3 m/year. With lowering water level are enlarging, lowering water level cone, salification, pollution of groundwater. Some places of Ho Chi Minh city, Vinh City, Hai Phong City, Cuu Long River Delta, Hai Hau, Quynh Phu, etc... have total Disolved Solid over 1g/l, Salinity is over 1g/l too.

Nitrogen pollution

The groundwater in some places of Hanoi is polluted by nitrogen and organic matters. Picture 1 shows that the average contents of NH_4 and organic (upon oxygen degrees) of the qh aquifer, qp_2 aquifer are higher than TCVN for drinking water (3 mg/l).

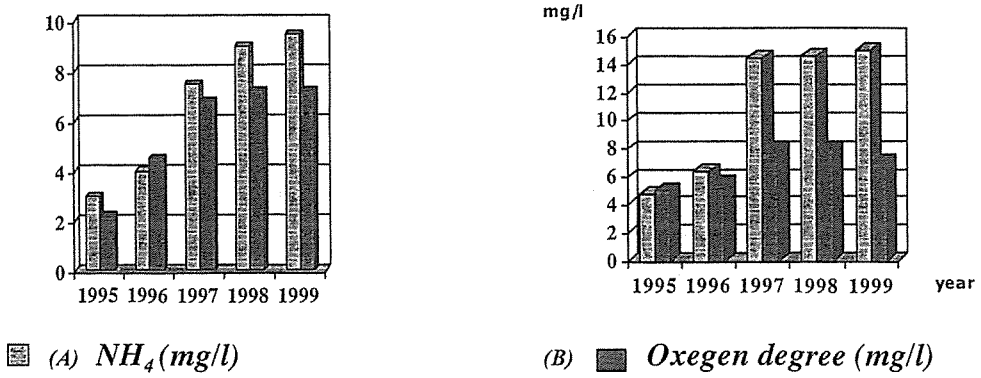


Fig. 1. (A)-Average content of NH_4 and Oxygen degree in qh aquifer in South Hong river - Hanoi city according time. (B)- Average content of NH_4 and Oxygen degree in qp^2 aquifer in South Hong river - Hanoi city according time.

Fluor pollution

Some places of Vietnam such as Dong Pao, Tam Duong, Ninh Hoa, Khanh Hoa have high contents of Fluor in groundwater. It is caused by fluorid minerals, which are near or in the regions through which groundwater streams run. The existing polluted situation is very often in thermal groundwater sources. Such areas as Vinh Hao, Chau Cat, Hoi Van, Que Loc, Phuoc Nhan have groundwater sources with concentration of Flour from 3mg/l to 10 mg/l. Especially, Vinh Hao stream (Khanh Hoa province) has 14 mg/l of Flour concentration. Many people living in the areas suffer from tooth decay and brittle bone.

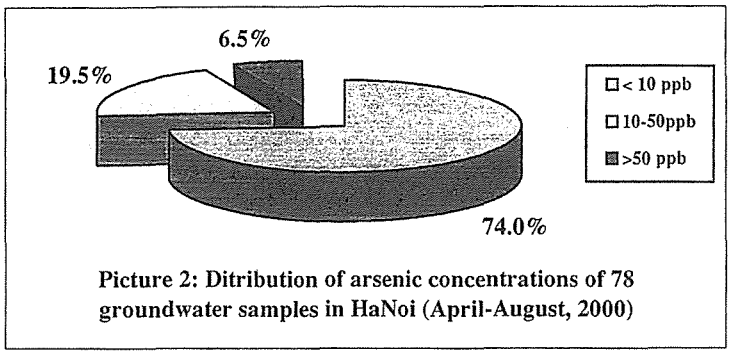
Arsen pollution

In Vietnam, there are three zones having Arsenic pollution. The first is the mountain zone of ore deposits of Au, Pb, Zn, their weathering crust and soil in upper part of Ma river, Khau Au, Cho Don, Ban Cau, Hoa Binh with high concentration of Arsen. Natural proccesses (hydrothermal and volcanic activities, weathering processes) are the only arsen pollution sources. The second is some places of delta plain, such natural processes as oxidation and reduction of arsenic minerals and human activities are the main pollution source of As. The third is the coastal zone (sea sediment of Phu Yen, Quang Ngai coastal polluted by As). It is caused by human activities such as pesticides, fertilizer and chemical weapon utilization.

The groundwater of the North of Vietnam is characterized by variable contents of As. For example, the content in Hanoi of As is about 10-500ug/l; in Viet Tri, 10-320ug/l; in Bac Giang, 0.1-19 ug/l; in Hai Phong, 1.7 - 9.4 ug/l; and Nam Dinh, 0.01 - 1.6 ug/l. Many recent studies have proven that groundwater in some places in Hanoi is polluted by very high concentration of Arsen. Its contents are more than 50ug/l (according to TCVN 5945-1995 for Parameter limits and maximum allowable concentrations of pollutants in groundwater). The situation has been found in both qp aquifer and qh aquifer.

Picture 2 shows variable arsenic concentrations in groundwater in Hanoi. Within the framework of the paper, 78 groundwater samples from groundwater sources used for water plants of Clean Water Business Companies and the "UNICEF" wells of families were analyzed. The figure in picture 2 indicates that about 6-7% of the sampling amount (with depth of family wells 25-40m) have high concentration, (i.e. over 50 ug/l), most of which are located in Hai Ba Trung district, especially in Quynh Loi area. In Quynh Loi, many households get water from the wells with high contents of Arsenic, for instance, a groundwater sample from Mrs. Ng. Th. Ng.'s family well contains 116 ug/l of As; Mrs. Tr. X. H.'s well has 228ug/l of As; the Training and Teaching

Professional school in the Bui Ngoc Duong street has a well with 290 ug/l of As, Mrs. Ng. V. D.'s family owns a well with 228ug/l of As.



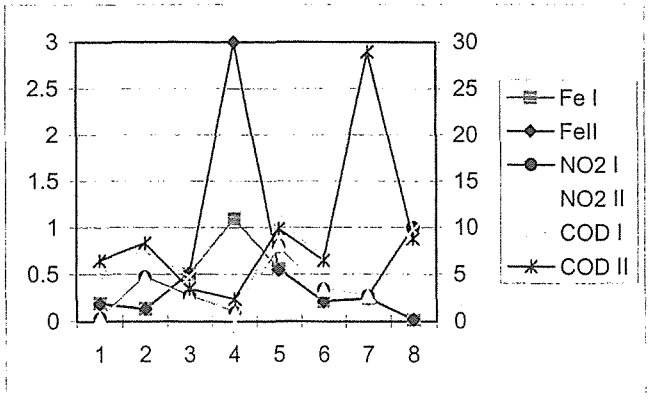
Picture 2: Ditribution of arsenic concentrations of 78 groundwater samples in HaNoi (April-August, 2000)

The concentration of As in groundwater sources is unstable according to time. It depends on when to take samples, in the morning or afternoon, in the dry or rainy season. In order to find the characterstic period of the concentration of As, much more time should be spent on State Project to study with the co-operation of many relevant ministries of Vietnam.

Analytical methods

Field Monitoring Apparatuses

The Digital Water Analyzer Aquasearch 8030 has been used to analyze some mobiling parameters of groundwater as iron, nitrite and COD (KMnO4). Eight samples were analyzed by the Portable Analyzer. Iron, Nitrite and COD are three unstable items that can be changed by an oxidation of air, absorption on the wall of sampling bottles. Fe^{2+} is oxidized to Fe^{3+} and precipited on the bottom and absorbed on the wall of bottles. Nitrite NO_2 is oxidized to Nitrate NO_3. COD could be decreased by bacteria. Others items of groundwater were analyzed in laboratory. Picture 3 shows the comparison between some results analyzed by Digital Water Analyzer 8030 and that analyzed in laboratory. The results gained by Field Analyzer are comparatively close to those received from laboratory with Spectrophotometric methods. However, almost all the results coming from field analyzer come up with a little higher concentration than that in laboratory, though the difference is quite unnoticeable, just about 10%. Only Fe concentration in Sample 4 and NO_2 concentration in Sample 8 were very high (over 1.1 mg/l and over 1.5 mg/l respectively), exceeding the measurable limit of the analyzer so the two methods could not be compared.



The Digital Water Analyzer Aquasearch 8030 is very useful for analyzing the unstable parameters of groundwater, its operation is very simple and accurate enough to study.

Analyze of Arsen

The analytical methods used to analyze Arsen are as follows:

- Atomic Absorption Spectrometer AAS, with hydride generation with $NaBH_4$. (Concentration range: 1-20ug/l)
- Silver DiethylDithioCarbamat Colorimetric in Pyridin and using Zn free As for reduction of AS (V) to As (III). (Concentration range: 5-250ug/l)
- SilverDiethylDithioCarbamat Colorimetric in mixture of Chloroform- Morpholine. And using Zn free As for reduction of AS (V) to As (III). (Concentration range: 5-250ug/l)

No.of Samples.	AAS- Hydrid generation	Ag-DDC-Pyridin	Ag-DDC- Mixture of Chloroform and Morpholine
1	0.077	0.076	0.070
2	0.037	0.039	0.033
3	0.008	0.006	0.007
4	0.079	0.082	0.075
5	0.116	0.121	0.118

Table 1. The comparison of analytical methods of Arsen in groundwater samples

According to *Table 1*, all of three methods came to nearly similar results. That Ag-DDC-mixture Chloroform and Morpholine method gave a little lower parameters is due to the loss of AsH_3 with the evaporation of Chloroform and Morpholine. However, pyridin is a very toxic solution that may cause bad effects on analysists' health. We, therefore, have tried to replace pyridin with the mixture of Chloroform and Morpholin to study, but the operation of the process is very complicated. Chloroform and Morpholin have so low vapor points that As will be lost during the hydrization of As in high temperature, we have to always add the mixture to keep its stable volumne.

Conclusion

Groundwater is one kind of specific natural resources. Process could be clearly inspected and evaluated before the exploitation is carried out. It is clear to identify the phenomenon of the pollutions of from Arsen, Fluor, Nitrogen, and organic matters in some places in Vietnam, especial in Hanoi. The Digital Water Analyzer, Aquasearch 8030, which is supported by Prof. Minoru Tanaka and JSPS, CUP program, have been well utilized for the evaluation of groundwater quality in the field monitoring. It is most effective to analyze Arsen in groundwater sources by Atomic Absorption Spectrometer, but Ag-DDC- Pyridein is very useful for poor laboratories that are in short of AAS.

Acknowledgement

On behalf of Institute of Chemistry, NCST, we would like to express our sincere thanks to Prof. Minoru Tanaka who has given the institute the Digital Water Analyzer Aquasearch 8030, and to Dr. Yuta Yasaka who has given the institute Morpholine to study.

References

1. Le Van Can, Le Thieu Son: *Groundwater in the nation's industrialization and modernization*. Proceeding of Seminar, Hanoi, 17 December 1997. Groundwater with rural water supply in Vietnam.
2. Tran Van Minh, Le Huy Hoang, Dang Van On: *Groundwater in the Nation's industrialization and modernization*. Proceeding of Seminar, Hanoi, 17 December 1997. Fresh groundwater resources in Northern Part of Vietnam.
3. Nguyen Van Dan: *As pollution, Current situation, its impacts on public health and preventive solution, Hanoi, December 2000*: Universal Hydrogeological Feature of Vietnamese friable Delta sediments and Water supply problem.
4. Dang Mai: *As pollution, Current situation, its impacts on public health and preventive solution, Hanoi, December 2000*. Potential of Pollution of Arsenic in Doi Bu Gold Ore Area.
5. *Standard methods for the examination of Water and Waste Water*, 1995, American Public Health Association
6. *ASTM Standard*, 1996
7. *International Standard*, ISO, 6595.
8. Nguyen Thi Phuong Thao, Do Trong Su: *Report on the workshop of Arsenic Pollution*, supported by Ministry of Planning and Investment, Hanoi, June 2000; Preliminary Study for Evaluation of Arsenic Pollutions in Groundwater in Hanoi.
9. Pham Hung Viet, Tran Hong Con, Nguyen Thi Chuyen: *As pollution, Current situation, its impacts on public health and preventive solution, Hanoi, December 2000*. Preliminary Survey for Evaluation of Arsenic Level in Ground and Supply Water in Hanoi Area.