ACTUAL SITUATION OF HEAVY METALS' CONTAMINATION IN GROUNDWATER OF HANOI AREA

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The water supply system of Hanoi depends on 8 main water treatment plants and 13 small stations belonging to Hanoi Water Business Company (HWBC). The exploitation capacity of HWBC was approximate 450,000 cubic meters per day in 1995 and it reached 500.000 cubic meter in 1998. HWBC provides water for about 70% of total urban population of Hanoi. Water supply productivity of HWBC on all system is about 70%. It means that the amount of water for 1 person per day is theoretically approximate 200 liter, but in reality this amount is still less. According to the Water Master Plan of Hanoi City up to 2000 the exploitation capacity will be 700.000 cubic meter per day. 100% of Hanoi supply water is produced from underground water. With actual exploitation capacity, appeared exhaustion in some wellfields located far from river influenced zone, where the recharge is not equivalent. These phenomena were appeared in southern part of Hanoi, especially in dry season [1].

Underground water in Hanoi is strongly influenced by two water resources. The first is water from Red River and Duong River and the second is from surface water and underground water from nearer areas. This conclusion can be explained by the hydrogeological structure of Hanoi area. In principle, the upper aquifer must be isolated from lower aquifer by layer of clay, which plays role as water filter. But the isolated layer of clay in Hanoi area is not indefectible, there are holes, which called hydrogeological windows in it. The holes are some where and especially larger in bottom of rivers. It means that ground water of lower aquifer, where water is exploited, directly contacts with surface water and river water. So quality of Hanoi underground water is very sensitive with contamination of surface water and river water.

Together with development of economics and industry and expanse of population of Hanoi, water exploitation must be intensified. Those really threaten quality of ground water in Hanoi.

The quality of ground water was investigated by some institutes and research organizations. But they were interested only in other parameters of water quality but heavy metals were still limited except Iron. The archived data of heavy metals in ground water up to now was still pure and wasn't systematical [2]. Those were reasons why we opened our investigation on subject of heavy metals' contamination in Hanoi underground water.

The first stage of our investigation is to determine the contamination of 8 important

and popular heavy metals in Hanoi ground water and hopping to find out any reason of this contamination. The heavy metals planed in the investigation were As, Hg, Pb, Cd, Cu, Ni, Fe and Mn [3].

The samples were collected directly from pump stations of 9 wellfields in Hanoi on dry season (February), beginning of rainy season (April) and on most rainy period (July). After collection, samples were pretreated with nitric acid, DO, pH, turbidity and temperature parameter of samples were measured immediately when ground water flowed out.

All samples were then treated with HCl and HNO_3 to destroy metal-organic compounds that changed metal compounds into simple dissolved metal ions. It's better in chloride form. It means all nitrate ions must be removed from analytical samples by multi times boiling down with HCl. Then diluted with HCl 1,0 M before measurement [4].

The analytical samples were measured by Atomic Absorption Spectrometric method on AAS 6800 Shimadzu. Fe, Mn, Ni, Cu, Cd, and Pb were measured with Air-Acetylene flame regime. Hg was measured with non flame cool vapor regime using Hydride Vapor Generator (HVG) equipment. As was measured with Air-Acetylene flame regime but it was used HVG technique to change all arsenic species onto arsine (AsH3). Then arsine was flowed into quart tube putted in the flame. AsH_3 was atomized in interior of heated quart tube without influence of exterior gases.

The concentration of 8 investigated heavy metals in underground water of nine exploiting wellfields in Hanoi area was showed in Table 1 (for dry season), Table 2 (for beginning rainy season), Table 3 (for most rainy period in rainy season) and table 4 (average value).

Table 1. Concentration (μg/l) of 8 heavy metals in ground water of 9 Wellfields in Hanoi area and Red River (February 1999)

Wellfields	Concentration of heavy metals in groundwater, (ppb)							
	Cd	Cu	Fe	Mn	Ni	Hg	Pb	As
Lương Yên	2.51	21.53	2152	400	8.07	0.85	33.73	57.74
Tương Mai	2.47	11.85	5350	260	7.10	1.11	31.85	78.05
Ng Sỹ Liên	2.63	7.72	1112	940	11.93	1.08	33.62	52.80
Ngọc Hà	2.94	7.50	825	1200	7.56	1.13	35.37	42.40
Yên Phụ	2.70	15.94	4691	420	7.48	0.82	37.02	404.33
Hạ Đình	2.60	20.32	8512	140	8.31	1.06	36.32	280.70
Pháp Vân	2.24	10.73	4324	15	5.89	1.51	44.12	348.3
Mai Dịch	2.19	7.77	261	1020	5.46	1.01	34.06	48.24
Henninger	2.24	6.29	4389	223	6.10	0.97	29.87	41.89
Sông Hồng	46.66	1.36	1055	7	5.35	0.85	43.46	390.05
VN Standard	10	100	300	100	100	50	1	50

Table 2. Concentration (μg/l) of 8 heavy metals in ground water of wellfields in Hanoi and Red River in beginning of rainy season (May 1999)

Wellfields	Concentration of heavy metals in ground water, (ppb)							
	Cd	Cu	Fe	Mn	Ni	Pb	Hg	As
Lương Yên	2.21	15.35	1961	471	7.76	35.50	0.76	68.35
Tương Mai	2.39	9.51	6932	351	6.05	37.28	1.03	76.15
Ng Sỹ Liên	2.20	2.55	1112	1055	6.08	41.41	1.14	52.55
Ngọc Hà	2.55	3.61	673	1192	6.64	39.19	1.15	33.85
Yên Phụ	2.67	4.56	4514	468	6.28	42.18	0.76	372.45
Hạ Đình	2.77	4.31	8830	150	9.40	40.53	1.01	292.06
Pháp Vân	2.24	3.16	3892	212	7.56	70.89	1.85	374.37
Mai Dịch	2.28	3.63	144	1310	6.06	39.41	1.01	48.33
Henninger	2.84	3.22	4123	321	5.78	39.33	3.21	42.36
Sông Hồng	42.37	1.42	1321	12	6.22	36.17	0.82	196.52
VN Standard	10	100	300	100	100	50	1	50

Table 3. Concentration (μg/l) of some heavy metals in ground water of 9 Well fields and Red River in most rainy period of rainy season (July 1999)

Wellfields	Concentration of heavy metals in ground water, (ppb)							
	Cd	Cu	Fe	Mn	Ni	Pb	Hg	As
Luong Yen	2.36	2.15	2333	228	1.48	15.79	0.41	55.03
Tuong Mai	1.34	3.39	4693	181	2.49	13.65	0.85	31.07
Ngo Sy Lien	1.78	1.71	1386	579	3.37	7.45	0.25	20.33
Ngoc Ha	0.59	3.34	301	16	3.31	16.75	0.06	44.48
Yen Phu	1.83	6.63	5123	249	3.05	7.35	0.51	412.32
Ha Dinh	0.52	1.75	7644	95	3.74	16.16	2.21	218.79
Phap Van	0.24	2.58	5271	109	2.42	15.03	0.27	303.79
Mai Dich	0.40	2.58	539	522	4.69	12.95	0.56	12.17
Red River	1.49	6.85	692	16	3.31	16.75	0.56	21.60
VN Standard	10	100	300	100	100	50	1	50

Table 4. Average concentration of heavy metals in ground water of Hanoi area (μg/l)

Wellfields	Average concentration of heavy metals in ground water							
	Cd	Cu	Fe	Mn	Ni	Pb	Hg	As
Luong Yen	2.52	13.07	2149	366	5.77	28.34	0.67	60.37
Tuong Mai	2.07	8.25	5640	264	5.21	27.59	1.00	61.76
Ngo Sy Lien	2.20	3.99	1203	858	7.13	27.49	0.82	41.89
Ngoc Ha	2.03	14.48	600	1627	5.84	30.42	0.78	40.24
Yen Phu	2.40	9.04	4776	379	5.60	28.85	0.70	396.37
Ha Dinh	1.96	8.79	8329	128	7.15	28.85	1.43	263.87
Phap Van	1.57	5.49	4496	112	5.29	43.35	1.21	342.17
Mai Dich	1.62	4.66	300	951	5.40	28.81	0.86	36.25
VN Standard	10	100	1000	500	100	50	1	50

VN Standard = Vietnamese Standard Allowable Concentration of these Heavy Metals in Ground Water.

Based on the results mentioned above, we have seen that for Cadmium, Copper, Nickel and Lead their concentration in ground water is lower than standard allowable concentration. Although the concentration of these metals were strongly fluctuated in comparison between the wellfields and the seasons; but they were always in the allowable range. Beside that Iron, Manganese, Mercury and Arsenic exist in Hanoi ground water with very high concentration, which was exceeded allowable limit. In some wellfields the concentration of these metals is even 5 to 10 times higher than allowable limit. For example: Iron in Ha Dinh, Phap Van, Yen Phu, Tuong Mai well field, Manganese in Ngoc Ha, Mai Dich, Ngo Sy Lien well field and Arsenic in Yen Phu, Ha Dinh, Phap Van well field.

The concentration of heavy metals in individual well field was also altered along with seasons in years. The trend of the variable seems that the concentration was high in dry season and lower in rainy season. It can be seen clearly at Figure 1 for Tuong Mai well field and Figure 2 for Ha Dinh well field. This rule is according with the mentioned metals, which have low concentration such as Cd, Cu, Ni, Pb and Hg. But for Fe, Mn and As, which have high concentration in ground water of most wellfields, the concentration variation did not accord with any rule. We could see it at Figure 3.

In general, contamination of 8 investigating heavy metals in Hanoi ground water was partly exposed. Four of them (Cd, Cu, Ni and Pb) have concentration not so high to be able to threaten ground water quality. The rest of them are Fe, Mn, Hg and As, they strongly contaminated ground water of Hanoi area. Although the concentration of Fe and Mn was so high but with actual technology of supply water treatment, Fe and Mn could be easly excluded. Meanwhile arsenic and mercury were difficult removed. They could be directly influence on health of people who used to use this water.

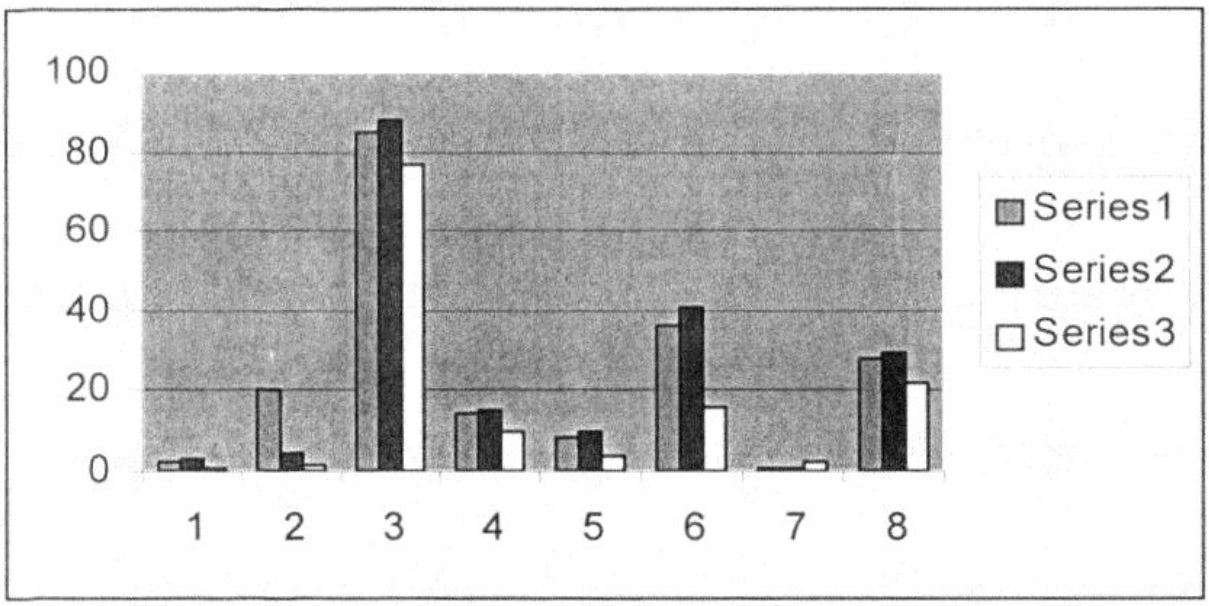

Figure 1. Concentration (µg/l) of 8 heavy metals in ground water in Tuong Mai well field on different seasons.
1: Cd, 2: Cu, 3: Fe, 4: Mn, 5: Ni, 6: Pb, 7: Hg, 8: As
Series 1: for dry season; Series 2: for beginning of rainy season;
Series 3: for most rainy period of rainy season.
(Concentration of [Fe] x 100, [Mn] x 10 and [As] x 10)

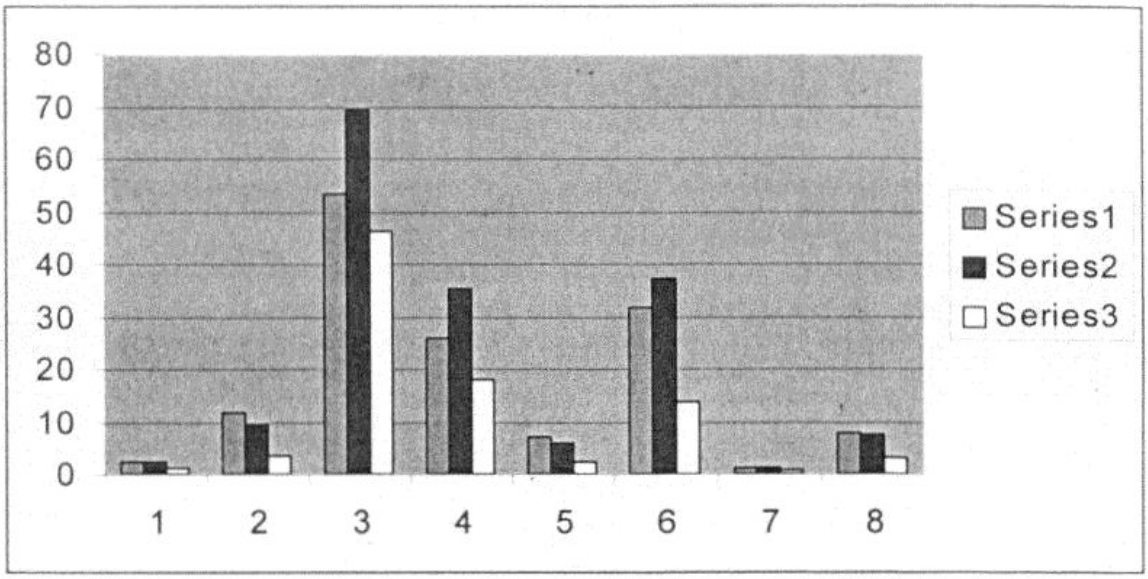

Figure 2. Concentration (μg/l) of 8 heavy metals in ground water of Ha Dinh well field on different seasons.
1: Cd, 2: Cu, 3: Fe, 4: Mn, 5: Ni, 6: Pb, 7: Hg, 8: As concentration
Series 1: for dry season; Series 2: for beginning of rainy season;
Series 3: for most rainy period of rainy season.
(Concentration of [Fe] x 100, [Mn] x 10 and [As] x 10)

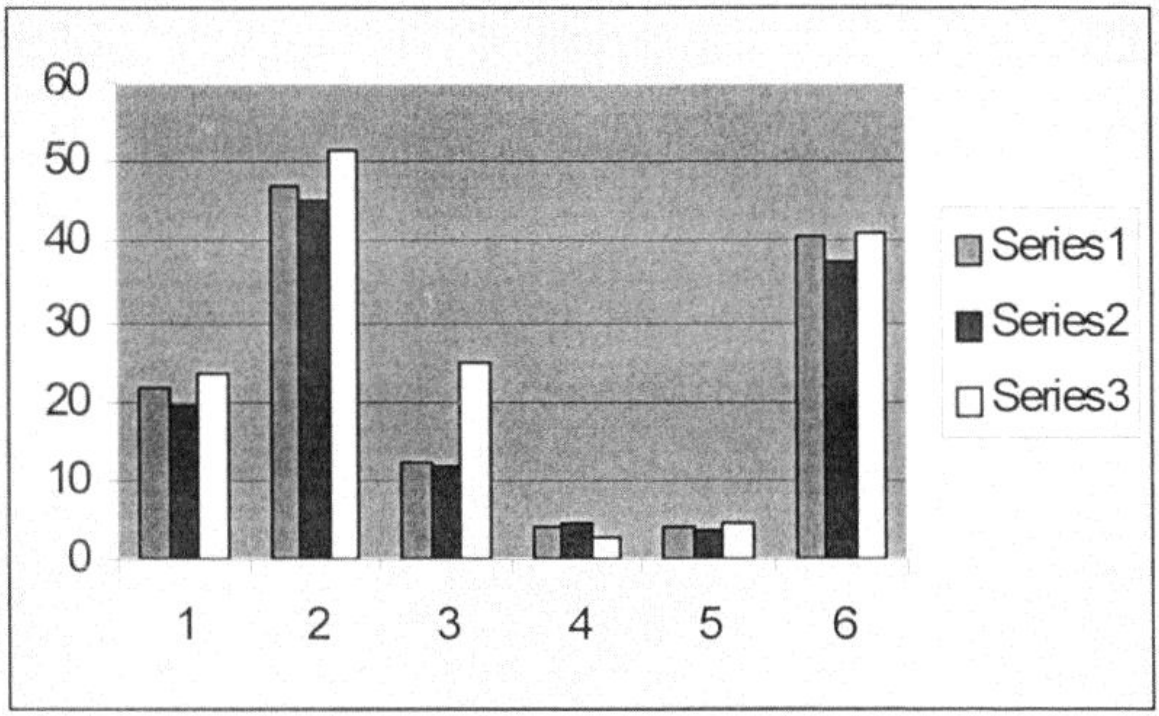

Figure 3. Concentration (μg/l) of Fe, Mn and As in ground water of Ngoc Ha and Yen Phu wellfield on different seasons.
1and 2: Fe concentration in Luong Yen and Yen Phu wellfield,
3 and 4: Mn, 5 and 6: As concentration in Ngoc Ha and Yen Phu wellfield.
Series 1: for dry season; Series 2: for beginning of rainy season;
Series 3: for most rainy period of rainy season.
(Concentration of [Fe] x 100, [Mn] x 10 and [As] x 10)

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TẠP CHÍ KHOA HỌC ĐHQGHN, KHTN, t.XVII, $n^0$1 - 2001

THỰC TRẠNG Ô NHIỄM KIM LOẠI NẶNG NƯỚC NGẦM Ở KHU VỰC HÀ NỘI

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Hầu như toàn bộ lượng nước cấp ở Hà Nội được khai thác từ nước ngầm với 8 bãi giếng lớn và khoảng 13 trạm nước nhỏ hơn. Chất lượng của nước ngầm khu vực Hà Nội đã được một số cơ quan nghiên cứu quan tâm và đã có những điều tra, khảo sát. Những tư liệu cho thấy các kim loại nặng trong nước ngầm cho tới nay chưa được quan tâm đến một cách thích đáng. Với những kinh nghiệm từ nước ngoài, năm 1999, chúng tôi đã triển khai đề tài nghiên cứu đánh giá tình trạng nhiễm kim loại nặng trong nước ngầm khu vực Hà Nội. Những kết quả thu được trong nửa đầu năm 1999 cho thấy một số bãi giếng của Hà Nội bị nhiễm kim loại nặng với nồng độ cao hơn nhiều so với tiêu chuẩn cho phép của Việt Nam như sắt, acsen ở bãi giếng Yên Phụ, Hạ Đình, Pháp Vân; Mangan ở Ngọc Hà, Ngô Sỹ Liên, Mai Dịch... Những kết quả còn cho thấy nồng độ của các kim loại nặng thay đổi tương đối rõ rệt giữa mùa khô và mùa mưa. Đối với 8 kim loại nặng đã được nghiên cứu thì đồng, chì, niken và cadimi luôn có nồng độ thấp hơn tiêu chuẩn cho phép còn sắt, mangan, acsen và thủy ngân trong một số bãi giếng có nồng độ cao hơn tiêu chuẩn. Với công nghệ xử lý nước ngầm như hiện nay tại các nhà máy nước thì không loại bỏ triệt để được mangan, thủy ngân và acsen. Đây là một vấn đề cần được quan tâm một cách nghiêm túc trong thời gian tới.