Arsenic Mitigation Initiatives and Sustainability Issues in Lowland Nepal

Arsenic mitigation initiatives and sustainability issues in lowland Nepal

Dr. Suman K. Shakya, Mr. Makhan Maharjan
Environment and Public Health Organization (ENPHO), New Baneshwor, Kathmandu, Nepal
P.O.: Box: 4102, Kathmandu, Nepal
Tel: +977-1-4493188, 4468641 Fax: +977-1-4491376

Abstract

Water source for all purposes in lowland Nepal with more than half of the total population of the country is primarily groundwater extracted from shallow or deep aquifers. According to blanket arsenic testing results, 7.5% of 1,120,912 samples exceeded WHO guideline value (10 ppb) with 1.8% samples above the national standard (50 ppb). Surveys in some arsenic affected communities have identified several hundred arsenicosis cases. Government, national and international organizations have implemented arsenic mitigation programmes aiming to prevent health damage and have provided different arsenic safe water alternatives to high arsenic exposed households. But peoples' awareness on arsenic and its health hazards is low and provided arsenic safe water alternatives are not regularly used in the communities. Furthermore, the local people recently have shown interest for long-term safe water facilities – piped water supply instead of household level options. Thus, the integrated approach for wider awareness generation, local capacity building on arsenic mitigation, resources mobilization and proper management with active community involvement is necessary for addressing the arsenic problem in a sustainable way in lowland Nepal.

Keywords: arsenic mitigation; sustainability issues; Nepal

1. Introduction

Nepal is a small landlocked South-Asian country bounded on the north by Tibet (China); on the east by Sikkim and West Bengal, on the south by Bihar and Uttar Pradesh, and on the west by Uttar Pradesh of India. Nepal's landscape is broadly defined by three contrasting physiographic bands, which run in more or less parallel, east to west: lowland (Terai) region in south; Hill region in central and Mountain region in north. Lowland region is a tropical and subtropical belt of flat alluvial deposits stretching along the Nepal-India border that comprises 20 districts out of total 75 districts. It is the northern extension of the Gangetic Plain, and constitutes the least 23% of the total land area of Nepal (NRA, 1997; ISRSC, 2002). Agriculture is the major livelihood of the people in lowland, and 90% of the lowland population depends on groundwater pumped up with tubewells for all domestic purposes including drinking.

Elevated arsenic level in drinking water and its health effects has become a public health threat in many Asian countries including Nepal (NRC, 2001; WHO, 2001; Ahmad *et al.*, 1997; Guha Mazumder *et al.*, 1998; Guo *et al.*, 2001; Maharjan *et al.*, 2005, 2006, 2007). Arsenic contamination, in Nepal, has been reported in groundwater extracted from shallow aquifer (NASC, 2011). It's noteworthy that more than half of Nepal's total population is living in 20 Terai districts (CBS, 2011) and 90% of them are relying on groundwater as their major source of water for all domestic purposes including drinking.

2. District-wise arsenic contamination in Terai, Nepal

The updated database of 1,120,912 water samples so far tested for arsenic levels in 20 Terai districts as of July 2008 reported 7.5% water samples to exceed the WHO guideline value of 10 ppb and 1.8% samples above the Nepal Standard of 50 ppb. The percentage of water samples exceeding 10 ppb of arsenic varied from 0.3% (Chitwan) to 26.0% (Nawalparasi), while it was 0.1% (Chitwan) to 12.3% (Nawalparasi) for samples exceeding 50 ppb of arsenic. This variation in arsenic contamination levels suggests that arsenic problem in Terai is more localized rather than uniform distribution (Table 1). Nawalparasi district has been identified to be the hot spot of arsenic contamination in Nepal.

Table 1
Summary of arsenic contamination in 20 Terai districts as of July, 2008 (NASC, 2008)

District	Tests	Arsenic conc^n (ppb)			% exceeding	
		upto 10	11-50	>50	10 ppb	50 ppb
Jhapa	97065	96296	715	54	0.8	0.1

Morang	112332	109865	2285	182	2.2	0.2
Sunsari	67085	64150	2519	416	4.4	0.6
Saptari	57094	53873	2630	591	5.6	1.0
Siraha	46625	39194	6112	1319	15.9	2.8
Dhanusha	60783	58026	2305	452	4.5	0.7
Mahottari	34007	33679	297	31	1.0	0.1
Sarlahi	50573	43235	6748	590	14.5	1.2
Rautahat	50506	39967	9393	1146	20.9	2.3
Bara	39837	35203	3147	1487	11.6	3.7
Parsa	28424	26071	1595	758	8.3	2.7
Chitwan	57628	57478	104	46	0.3	0.1
Nawalparasi	32219	23844	4418	3957	26.0	12.3
Rupandehi	75396	72316	2567	513	4.1	0.7
Kapilbastu	39915	36060	2662	1193	9.7	3.0
Dang	26949	26725	175	49	0.8	0.2
Banke	45191	43083	1840	268	4.7	0.6
Bardiya	61501	55646	3150	2705	10.5	4.4
Kailali	84543	74460	7193	2890	11.9	3.4
Kanchanpur	53239	47330	4313	1596	11.1	3.0
Total	**1,120,912**	**1,036,501**	**64,168**	**20,243**	7.5	1.8

3. Skin manifestations

Health surveys on chronic arsenic poisoning in some arsenic contaminated districts of Terai, namely, Nawalparasi, Bara, Parsa, Rautahat, Rupandehi, Kapilvastu and Kailali have identified several hundred arsenicosis cases. The highest prevalence of arsenicosis was found in Nawalparasi district, which was also reported to be a highly arsenic contaminated district. The prevalence of arsenicosis for male was higher as compared to female, suggesting male suffering more from arsenicosis. Though there are limited studies on health effects of arsenic poisoning, the available data in Nepal have shown melanosis as the dominant manifestation (Maharjan et al., 2005, 2006, 2007; RVWRMP, 2008).

Several preceding studies in India and Bangladesh have also reported skin lesions to be the most common health effects in populations exposed to arsenic through drinking water and the prevalence of arsenicosis for male was higher as compared to female (Ahmad et al. 1999; Guha Mazumder et al. 1998; Watanabe et al. 2001). Though there are other un-explained factors like nutritional status of the subjects, genetic factors that cause sex difference for arsenicosis, or resistance to arsenic toxicity, which might be influencing the occurrence of arsenicosis more in male, it is reported that ingestion of more arsenic through increased amount of drinking water by male is higher compared to that of female and that might have contributed for the higher prevalence of arsenicosis in male. Since the arsenicosis cases observed either pigmentation changes or keratotic lesions were in early stage, they are expected to recover soon if further exposure is stopped by using arsenic safe water for drinking and cooking purpose.

4. Mitigation initiatives and sustainability issues

Arsenic mitigation programmes in lowland have basically focused on provision of arsenic safe water alternatives to high arsenic exposed households that include arsenic safe tubewells, sanitary improvement of existing dugwells and arsenic removal filters. Rainwater harvesting, though promoted as one of the arsenic safe water alternatives, has very limited acceptability in lowland Nepal due to roof type, height of houses etc.

Inadequate awareness and lack of monitoring of the provided options have resulted in discontinuing or irregular use of the provided arsenic safe water alternatives in the communities. Our experience showed that lack of monitoring, inadequate awareness of the people and chronic arsenic toxicity nature are the bottleneck for regular use of the provided arsenic safe alternatives. This has recently raised the concerns on sustainability of the mitigation efforts taken. The mitigation of arsenic from drinking water is very challenging which should be technically efficient, socially accepted and economically affordable. Furthermore, public awareness and capacity building at the local level are equally important for addressing the problem sustainably. Good coordination and sharing of experiences among all relevant stakeholders are

other essentials to maintain uniformity in mitigation programmes and stop duplication of similar activities in the same place by different organizations, agencies, institutions etc. The local people recently have shown interest for long-term safe water facilities – piped water supply instead of household level options. Thus, the integrated approach for wider awareness generation, local capacity building, resources mobilization and proper management with active community involvement is necessary for addressing the arsenic problem in a sustainable way in lowland Nepal.

5. Conclusions

Groundwater in lowland Terai is arsenic contaminated and there exist its health effects as skin manifestations. Both government and non-governmental organizations have made continuous efforts for arsenic mitigation. Lack of monitoring and awareness on arsenic related problems have recently raised the concerns on sustainable use of the provided arsenic safe water alternatives. The experience has suggested the need of the integrated approach for wider awareness generation, local capacity building, resources mobilization and proper management with active community involvement for sustainable arsenic mitigation in lowland Nepal.

6. References

Ahmad SA, Bandaranayake D, Khan AW, Hadi SA, Uddin G, Halim MA. (1997). Arsenic contamination in groundwater and arsenicosis in Bangladesh. *Int J Environ Health Res,* 7:271-276.

Ahmad SA, Sayed MHSU, Hadi SA, Faruquee MH, Khan MH, Jalil MA, et al. (1999) Arsenicosis in a village in Bangladesh. *Int J Environ Health Res* 9:187-195.

CBS. (2011). Central Bureau of Statistics, Kathmandu, Nepal.

Guha Mazumder DN, Haque R, Ghosh N, De BK, Santra A, Chakraborty D, et al. (1998) Arsenic levels in drinking water and the prevalence of skin lesions in West Bengal, India. *Int J Epidemiol* 27:871-877.

Guo X, Fujino Y, Kaneko S, Wu K, Xia Y, Yoshimura T. (2001). Arsenic contamination of groundwater and prevalence of arsenical dermatitis in the Hetao plain area, Inner Mongolia, China. *Mol Cell Biochem*, 222:137-140.

ISRSC. District Demographic Profile of Nepal. Informal Sector Research and Study Center, Kathmandu, Nepal. 2002.

Maharjan M, Watanabe C, Ahmed Sk, and Ohtsuka R. (2005) Arsenic contamination in drinking water and skin manifestations in Lowland Nepal: The First Community-based Survey. *Am. J. Trop. Med. Hyg.,* 73(2):477-479.

Maharjan M, Shrestha RR, Ahmed Sk, Watanabe C, and Ohtsuka R. (2006) Prevalence of arsenicosis in *Terai*, Nepal. *J Health, Popul Nutr,* 24(2, Pt 1):251-257.

Maharjan M, Watanabe C, Ahmed Sk, Umezaki M and Ohtsuka R. (2007) Mutual interaction between nutritional status and chronic arsenic toxicity due to groundwater contamination in an area of Terai, Lowland Nepal. *J. Epidemiol.Community Health 2007;61;389-394.*

NASC. National Arsenic Steering Committee, Summary of Blanket Arsenic Testing Results in Nepal – as of July 2008.

NASC. The State of Arsenic in Nepal – 2011. National Arsenic Steering Committee, December 2011, Draft Report.

NRA. NEPAL, District Profile. National Research Associates (NRA), Kathmandu, Nepal. 1997, 361-384.

NRC. Arsenic in Drinking Water: 2001 Update. National Research Council, National

RVWRMP. A health impact survey in arsenic affected areas in three VDCs of Kailali district, Final Report, 2008.

Watanabe C, Inaoka T, Kadono T, Nagano M, Nakamura S, Ushijima K, et al. (2001) Males in rural Bangladeshi communities are more susceptible to chronic arsenic *p*oisoning than females: Analyses based on urinary arsenic. *Environ Health Perspect* 109(12):1265-1270.

WHO. Environmental Health Criteria 224: Arsenic and Arsenic Compounds. 2nd ed. World Health Organization, Geneva 2001.