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**Status of Arsenic Concentration in Drinking Water and
Awareness of Arsenicosis among Risk Group and Health
Personnel of Rampurkhap Village Development
Committee of Rautahat District, Nepal**



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Yogendra Prasad Bhagat

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SUMMARY



Nepal is divided into three ecological zones: Mountain, Hill and Terai. The Terai belt which is narrow plain area laying in southern part of the country. The geology of this region is similar to west Bengal of India and Bangladesh where carcinogenic and poisonous chemical called arsenic has been detected in ground water higher than the permissible level. In Nepal, 90% of people in Terai region are using tube-well for cooking and drinking water. Arsenic has been detected here as well above the permissible level in the tube wells of the region. Concentration of arsenic in drinking water may be increasing due to excessive extraction of ground water. Arsenic contamination in drinking water causes Arsenicosis disease in the community. The cause of the disease is mainly due to the consumption of high concentration of arsenic in drinking water. This study has two fold aims: first is concerned to assess the status of arsenic concentration in ground water in the study area and second is to examine the awareness of people and health personnel about arsenic problem, and how they have managed the problem. The symptoms of arsenicosis like Keratosis and Melanosis on different parts of the risk population had been observed.

A descriptive cross sectional study was carried out in Rampurkhap V D C of Rautahat district. Arsenic concentration of 126 sample of drinking water source in the study area was selected randomly using lottery method and arsenic field- test kit was used to analyze arsenic concentration. This study also included 44 samples, which was previously tested by District Red Cross office Rautahat that gave good opportunity for cross checking of the water sample analysis. All the households consuming water above $50 \mu\text{g/L}$ of arsenic concentrations in Rampurkhap VDC was considered as the risk households. This study is the first attempt in Nepal to assess the awareness of community people and health personnel about arsenic and its problem in drinking water. The risk group was assessed for awareness of arsenic problem by using structured questions. 6.2% people were found aware of arsenic and its problem. Only 16.6% health personnel were found aware of arsenic and its effect on human health. Maximum concentration of $213 \mu\text{g/L}$ of arsenic was found in drinking water in this VDC. While measuring the arsenic concentration in drinking water in 126 samples, 55 samples (43.7%) were found above acceptable limits i.e. more than $50\mu\text{g/L}$. All the households consuming water from these sources were considered as risk households with family members of 1044. These family members were observed for Arsenicosis symptom based on observation sheet. Prevalence of arsenicosis symptoms and signs was found 1.8%.

As the study showed that more than 40% of sampled households were at risk, hence the problem should be considered in priority and national policy should be made to supply potable drinking water in the community. All the health workers of Terai should be given training regarding arsenicosis problem and preventive measures. There should be massive community awareness program in the community.

Abbreviations

AHW = Auxiliary Health Worker

As = Arsenic

DWSS = Department Of Water Supply And Sewerage

DOEH = Department Of Occupational And Environmental Health.

ENPHO = Environment And Public Health Organization

FCHV = Female Community Health Volunteer

ft = Feet

HCL = Hydrochloric Acid

L = Liter

MCHW = Maternal and Child Health Worker

NIPSOM = National Institute Of Preventive and Social Medicine

NRCS = Nepal Red Cross Society.

Ppb = part per billion

TBA = Traditional Birth Attendant

VDC = Village Development Committee

VHW = Village Health Worker

WHO = World Health Organization

Tables

1.1	Maximum arsenic concentration detected in Terai district	12
1.2	Arsenic concentration in different VDC of Rautahat	13
1.3	In dependent and dependent variables	18
1.4	Distribution of age, sex and religion of respondents	25
1.5	Education, occupation and economic status of respondents	26
1.6	Awareness of respondents on types of mitigation measure	30
1.7	Patients with arsenicosis signs and symptoms	32
1.8	Arsenic concentration in drinking water consumed by arsenicosis patients	33
1.9	Arsenicosis patients with duration of drinking water of risk level	34
1.10	Prevalence of Arsenicosis symptoms and signs by age group	36
1.11	Prevalence of arsenicosis symptoms and signs by gender	37
1.12	Prevalence of arsenicosis symptoms and signs by religion	37
1.13	Prevalence of arsenicosis symptoms and signs by occupation	38
1.14	Prevalence of arsenicosis symptoms and signs by economic status	39
1.15	Prevalence of arsenicosis symptoms and signs by education level	40
1.16	Prevalence of arsenicosis symptoms and signs by ethnicity/caste	41
1.17	Prevalence of arsenicosis symptoms and signs by awareness	42

Figure

	Page
1. Arsenic concentration in drinking water	27
2. Arsenic concentration and depth of tube wells	28
3. Awareness of Respondents on Arsenicosis	29
4. Distribution of respondents by mitigation measure.	30
5 Awareness of arsenicosis among health personnel	31

Contents

	Page
Approval Sheet	i
Acknowledgement	ii
Summaries	iv
Abbreviations	vi
Tables	vii
Figures	viii
Contents	
Chapter - I	
Introduction	
1.1 Background of the study	1
1.2 Statement of the problem	3
1.3 Rational of the study	4
Chapter-II	
Literature review	
2.1 Arsenic	6
2.2 Environmental fate	7
2.3 Arsenic as a global health problem	8
2.4 Arsenic removal	14
Chapter- III	
Research questions and objectives	
3.1 Research questions	15
3.2 Objectives	15

Chapter – IV

Methodology

4.1 Study Area	16
4.2 Conceptual framework	16
4.3 Study Method	17
4.4 study design	17
4.5 variables	18
4.6 study population	18
4.7 Sample population	18
4.8 Sampling units	18
4.9 Sampling frame	19
4.10 Unit of analysis	19
4.11 Sample size	19
4.12 Sampling technique	19
4.13 Instrumentation	19
4.14 Exclusion criteria	19
4.15 Inclusion criteria	20
4.16 Indicators	20
4.17 Data collection method	21
4.18 Data collection procedure	21
4.19 Sample test procedure	22
4.20 Ethical consideration	22
4.21 Data processing and analysis	22
4.22 Validity and reliability	22
4.23 Operational definitions	23
4.24 Limitation of the study	24

Chapter-V

Findings

5.1 General characteristics of respondents	25
5.2 Level of Arsenic concentration in drinking water	27
5.3 Arsenic concentration by depth of wells	28
5.4 Awareness of arsenicosis among respondents	29
5.5 Mitigation measures by respondents	30
5.6 Awareness of arsenicosis among health worker	31
5.7 Patients with arsenicosis symptoms and signs by sites	32
5.8 Arsenicosis patients and consumption of water with arsenic concentration	33
5.9 Arsenicosis patients by duration of water with risk level	34
5.10 Prevalence of arsenicosis symptoms and signs in risk group	35
5.11 Prevalence of arsenicosis symptoms and signs by age group	36
5.12 Prevalence of arsenicosis symptoms and signs by gender	37
5.13 Prevalence of arsenicosis symptoms and signs by religion	37
5.14 Prevalence of arsenicosis symptoms and signs by occupation	38
5.15 Prevalence of arsenicosis symptoms and signs by economic status	39
5.16 Prevalence of arsenicosis symptoms and signs by education	40
5.17 Prevalence of arsenicosis symptoms and signs among ethnicity	41
5.18 Prevalence of arsenicosis symptoms and signs by awareness	42
5.19 summary of findings	42

Chapter- V1	
Discussion	43
Chapter- V11	
Conclusions	46
Recommendations	46
References	47
Annexes	
Survey questionnaire	49
Observation checklist	52
Map of the study area	53
Some Photographs	56

Chapter I

Introduction

1.1 Background of the study

Arsenic is a ubiquitous element found in the atmosphere, soils and rocks, natural water and organisms. It is mobilized in the environment through a combination of natural process such as weathering reactions, biological activity and volcanic emissions as well as through a range of anthropogenic activities. Most environmental arsenic problems are the result of mobilization under natural conditions, but man has an important impact through mining activity, combustion of fossils fuel, the use of arsenical pesticides, herbicides and crop desiccants and the use of arsenic as an additive to livestock feed, particularly for poultry. The impact on environment of the use of arsenical compounds, at least locally, will remain for years.

Of the various sources of arsenic in the environment, drinking water probably poses the greatest threat to human health. Every human being should have access to safe water for drinking and appropriate sanitation. But surface water (rivers, lakes and ponds), ground water and rainwater are at risk of arsenic contamination. High concentrations of arsenic are found in ground waters. Intake of arsenic from air is negligible in human being. The inorganic compounds of arsenic act as a local irritants to the skin and mucus membrane. Arseniuretted hydrogen acts as a hemolytic agent, causing haemoglobinuria, anemia, and hemolytic jaundice.

In Bangladesh, Department of Public Health Engineering and the other concerned organizations tested about 80-thousand tube wells water from various site of the country and found the existence of arsenic in 210 out of 460 upazillas. In the tested tube wells 50% contains arsenic more than the level permissible for Bangladesh. The experts opined that if no rapid action taken to prevent arsenic problem 200,000 people will die from cancer within a few years. Department of Occupational and Environmental Health (DOEH), National Institute of Preventive and Social Medicine (NIPSOM), Mohakhali, Dhaka-1212, Bangladesh epidemiological study, which was carried out in arsenic affected village of southwestern districts of Bangladesh. Of the total tube wells of the village 87% had arsenic concentration more than the maximum permissible limit of WHO guideline. The mean arsenic concentration of the tube well water was 0.240 mg/L and about 10 % of the villagers were found to be suffering from arsenicosis.

Most of the arsenicosis patients were between 10 to 39 years of age. Male patients were more common than female. None of the villagers who consumed tube well water having arsenic levels less than 0.082 mg/L were found to be suffering from arsenicosis. Melanosis and keratosis were the common clinical manifestations of the arsenicosis patients. Today, arsenic contamination through groundwater is not limited to Bangladesh or India or other few countries but rather a possibility in other parts of the world where extraction of ground water has become an alternative to surface water supply. We cannot exactly say in the case of Nepal that there is over extraction of ground water, but in the Terai region, with similar activities of over extraction and geological characteristics, and from the previous studies, there is a possibility of such problem in years to come. Therefore, it is important to know the status of arsenic in drinking water and health problems caused by arsenic contaminated drinking water in the community of Terai.

Rautahat district is administratively divided into four electoral constituencies, 15 ilaka, one municipality, and 96-village development committee. It is a Terai district boarding with Sarlahi in the east, Bara in the west, and Makwanpur in the north and Bihar state of India in the south. The district headquarter is in Gaur municipality. The estimated population of the district (fiscal year 2059/60) is 5,57,920. The area occupied by the district is 1122 square kilometer. The climate of the district is hot. There is one district hospital, three primary health centers, nine health posts and 85 sub health posts. There is also one Aurvedic health center and two Aurvedic Aushdhalaya. Rampurkhap village development committee is situated in the west 11 kilometers from the district headquarter. Initially, the study was purposed for Sangrampur village development committee but district Red Cross office had repaired old wells and most of the people were drinking water from arsenic free wells. Therefore, the study was shifted to Rampurkhap, which had also high contamination of drinking water with arsenic. The population of the VDC was 4304.

1.2 STATEMENT OF THE PROBLEM

Arsenic contamination in drinking water is causing health problems in the community. It is a global concern as it has affected so many countries like South Africa, Mexico, Zimbabwe, British Columbia, England, United States of America, Greece, Ghana, Argentina, Chile, Hungary, Vietnam, China, India, and Bangladesh etc. Health problems related to arsenic were first recognized in northern Chile in 1962. Typical symptoms included skin pigmentation, keratosis, squamous cell carcinoma (skin cancer) with cardiovascular problems. It has been estimated that around 7% of all deaths occurring in Chile between 1989- 1993 were due to exposure to arsenic in drinking water. In 1997, around 1000 people have been diagnosed with arsenic related skin disorders. Arsenic contamination in drinking water is now wide spread in Asia. We need fact-finding surveys, treatment of patients of arsenicosis. It is a matter of great concern that Asian countries are under a great threat of ground water with arsenic contamination. South Asian countries like India and Bangladesh are victims of arsenicosis. The problem of arsenic contamination was realized in 1990-1991 A.D. when several cases of arsenicosis were observed in the West Bengal and along the boarder areas of Bangladesh and West Bengal. Today in Bangladesh, 59 districts out of 64 districts and more than 70 million people are likely to be affected with arsenic contamination. Until 1998, there were 2200 severe cases of arsenicosis in the country. In Bangladesh, prevalence of arsenicosis is 10-33% and in west Bengal, India is 15%. It has been announced that it is one of the biggest epidemic of the world recorded in the history.

Realizing this problem and the extent of arsenic contamination, a few studies were conducted by different agencies from 1999-2000 A.D. in Terai districts of Nepal. During the study, 14450 wells had been tested for arsenic concentration. Nearly 28% of the wells exceed the WHO. Guideline value of 10 microgram per liter and 5% exceed the Bangladesh, India and interim Nepal standard of 50 μ g/L. Prevalence of arsenicosis in Nawalparasi was 5.1% (observed sample population-855), drinking water concentration >50 μ g/L (Shrestha.M.P, Shrestha R.R., et al.). More than 20% of adult population in Kunwar village of Nawalparasi had arsenic symptoms and arsenic level in water was found above 500 μ g/L (Shrestha MP, Shrestha RR et al.). On the basis of studies, so far conducted, the 4 most greatly affected districts were found to be Nawalparasi, Parsa, Bara and Rautahat. Therefore this study is concerned to know the

overall status of arsenic concentration in the drinking water , knowledge, practice of the risk group (consuming water above 50 ppb of As) and the health personnel.

1.3 Rational of the study:

- Due to increasing extraction of ground water in Terai region the concentration of arsenic is increasing and this slow poison is causing health problems in Terai dwellers. About 11 million people are living in Terai region and drinking ground water. Therefore they are at risk of arsenicosis.
- There can be no state of positive health and well being without safe drinking water. Each country is obliged to provide safe drinking water to its people. Safe drinking water is a basic element of primary health care. Therefore, HMG/Nepal has formed a National steering committee on Arsenic problem consisting 19 members to coordinate and solve the problem recently. 10th five year plan aims to provide safe drinking water for 85% population.
- As there is a great epidemic of arsenicosis in neighboring Bangladesh, we must be alert to prevent the occurrence of epidemic in our country. Hence, it is necessary to know the concentration of arsenic in drinking water, awareness of arsenicosis among people of Terai community and health personnel and also about mitigation measure. It is also important to assess the arsenicosis symptoms among people of Terai community. Therefore, this study will be an asset for society, as it will reveal arsenicosis and its awareness among people and health personnel to prevent, melanosis, keratosis, skin cancer, and arsenic poisoning.
- According to National arsenic committee 2001, arsenic concentration was found 146µg/L in Rautahat district. There is no any study regarding awareness of arsenicosis among different levels of people have been done though Rautahat district is also one of the highly affected district and for this the district is selected. According to survey (2002) of Nepal Red Cross society, 34 tube-wells were tested in which 26 (76%) have more than 50ug/L of arsenic in Sangrampur VDC of

Rautahat district and Rampurkhap VDC was next to it. Though the study was purposed for Sangrampur VDC initially, yet it was done in Rampurkhap V.D.C. because district Red cross office had supplied drinking water by renovating old wells with no arsenic in drinking water.

LITERATURE REVIEW

2.1 Arsenic

Arsenic exists in oxidation states of -3, 0, 3, and 5. It is widely distributed throughout the earth's crust, most often as arsenic sulfide or as metal arsenates and arsenides. Arsenicals are used commercially and industrially as alloying agents in the manufacture of transistors, lasers, and semiconductors, as well as in the processing of glass, pigments, textiles, paper, metal adhesives, wood preservatives, and ammunition. They are also used in the hide tanning process and, to a limited extent, as pesticides, feed additives, and pharmaceuticals.

Arsenic is released in ground water in soluble form in the following three mechanisms (Tandukar 2001 and. BGS and Mott MacDonald)

- a. **Oxidation of arsenopyrites or pyrites (FeAsS):** These substances, laid down into the subsoil strata over the centuries by rivers, get oxidized due to air leak through wells or standpipes and soluble arsenic contaminate the water source. Similarly, the aeration of any aquifer containing pyrites releases arsenic as soluble form.
- b. **Reduction of oxy-hydroxides:** Arsenic is naturally transported and is absorbed on to iron or manganese oxy-hydroxides. Under reducing environment, usually by activities of reducing microorganisms or reduction in ionic oxygen in geological strata, arsenic undergoes dissolution and released in subsoil water sources.
- c. **Adsorption of arsenic by phosphate:** The increase in phosphate concentration (PO_4) from fertilizers could promote adsorption of arsenic from iron and manganese-oxides or hydroxides in the form of arsenate AsO_4 resulting increase in arsenic concentration in ground water.

2.2 Environmental fate

Arsenic is introduced into water through the dissolution of minerals and ores, from industrial effluents, and via atmospheric deposition. In well-oxygenated surface waters, arsenic is generally the most common species present under reducing conditions, such as those often found in deep lake sediments or groundwater, the predominant form is arsenic. An increase in pH may increase the concentration of dissolved arsenic in water.

"Our understanding of arsenic compounds began in 1733 AD. When Brandt showed that white arsenic was the oxide of the element arsenic."⁷

"Arsenic is introduced into water through the dissolution of minerals and ores, from industrial effluents of industries and atmospheric deposition."⁸

Environmental levels and human exposure

Air:

"Arsenic concentrations in air range from (0.4 to 30 ng/m³); higher concentrations are present in the vicinity of industrial sources."¹

Water:

"The level of arsenic in natural waters generally varies between 1 and 2 µg/liter. Concentrations may be elevated, however, in areas containing natural sources; values as high as 12 mg/liter have been reported."¹

Food:

"Fish and meat are the main sources of dietary intake of arsenic levels ranging from 0.4 to 118 mg/kg have been reported in marine fish sold for human consumption, and concentrations in meat and poultry can be as high as 0.44 mg/kg. The mean daily intake of arsenic in food for adults has been estimated to range from 16.7 to 129 µg."¹

Estimated total exposure and relative contribution of drinking-water:

The estimated mean daily intake of arsenic from food is approximately 40 µg, about 10 µg of which is inorganic arsenic. The mean daily intake of arsenic from drinking water will generally be less than 10 µg, based on a concentration of arsenic in drinking water in areas without

natural sources of less than 5 µg/liter and an average daily consumption of 2 liters of drinking water. The estimated mean daily intake of arsenic from food is approximately 40 µg, about 10 µg of which is inorganic arsenic. The mean daily intake of arsenic from drinking water will generally be less than 10 µg, based on a concentration of Arsenic in drinking water in areas without natural sources of less than 5 µg/liter and an average daily consumption of 2 liters of drinking water. The estimated intake from air is generally less than 1 µg.

2.3 Arsenicosis as a global health problem

" Although the results of available studies indicate that arsenic may be an essential element for several animal species (e.g. goats, rats, and chicks), there is no evidence that it is essential for humans.

The acute toxicity of arsenic compounds in humans is predominantly a function of their rate of removal from the body. Arsine is considered to be the most toxic form, followed by the arsenites [arsenic (III)], the arsenates [arsenic (V)] and organic arsenic compounds. Lethal doses in humans range from 1.5 mg/kg of body weight (diarsenic trioxide) to 500 mg/kg of body weight). Acute arsenic intoxication associated with the ingestion of well-water containing 1.2 and 21.0 mg of arsenic per liter has been reported. Early clinical symptoms of acute intoxication include abdominal pain, vomiting, and diarrhea, muscular pain, and weakness, with flushing of the skin. These symptoms are often followed by numbness and tingling of the extremities, muscular cramping, and the appearance of a popular erythematous rash. Within a month, symptoms may include burning parenthesis of the extremities, palm plantar hyperkeratosis, Mee's lines on fingernails, and progressive deterioration in motor and sensory responses. Signs of chronic arsenicosis, including dermal lesions, peripheral neuropathy, skin cancer, and

"Peripheral vascular disease, have been observed in populations ingesting arsenic-contaminated Drinking water. Dermal lesions were the most commonly observed symptoms, occurring after minimum exposure periods of approximately 5 years. Effects on the cardiovascular system were observed in children consuming arsenic-contaminated water (mean concentration 0.6 mg/liter) for an average of 7 years." ⁸

In a large study conducted in China (Province of Taiwan), population of 40 421 was divided into three groups based on the arsenic content of their well water (high, >0.60 mg/liter;

medium, 0.30–0.59 mg/liter; and low, <0.29 mg/liter)). There was a clear dose–response relationship between exposure to arsenic and the frequency of dermal lesions, "Blackfoot disease" (a peripheral vascular disorder), and skin cancer.

In a study in which cancer mortality was examined in relation to arsenic content of contaminated drinking-water in the same villages of China (Province of Taiwan) and at the same three levels, there were significant dose–response relationships for age-adjusted rates for cancers of the bladder, kidney, skin, and lung in both sexes and cancers of the prostate and liver in males). A study in which the ecological correlations between the arsenic level of well-water and mortality from various malignant neoplasm's in China (Province of Taiwan) were examined demonstrated a significant association with the arsenic level in well-water for cancers of the liver, nasal cavity, lung, skin, bladder, and kidney in both males and females and for prostate cancer in males

"In a study conducted in Mexico, the health status of the populations of two rural towns was examined, the towns differing in the average arsenic concentrations of their water supplies, which was 0.41 ± 0.114 mg/liter ("exposed") in the first and 0.005 ± 0.007 mg/liter ("control") in the second. The prevalence of nonspecific symptoms, such as nausea, abdominal pain, and diarrhea, was significantly higher in the "exposed" population; the relative risks for these symptoms ranged from 1.9 to 4.8, while that of developing coetaneous lesions ranged from 3.6 to 36. The prevalence of skin cancer in the "exposed population in Mexico was 6.4%, as compared with 1.06% in the population with similar exposure in China (Province of Taiwan) (0.30–0.59 mg/liter group) .The south – west costal zone was perhaps the first area to be identified as a problem area for health effects arising from chronic arsenic exposure. Arsenic problems were also documented in north – eastern part of the island Awareness of the arsenic problem began during the 1960s." ⁹

China: "Arsenic has been found at high concentration ($>50\mu\text{g/L}$) in ground water from inner Mongolia as well as Xijiang and Shanxi provinces. The first cases of arsenic poisoning were recognized in Xinjiang province in the early 1980s. Wang (1984) found arsenic concentration in ground water from the province at up to $1200\mu\text{g/L}$." ⁹

Vietnam: "Preliminary results from Hanoi indicate that there is a significant arsenic problem in shallow tube wells in the city." ⁹

Hungary: "Concentration of arsenic above 50µg/L have been identified in ground water from alluvial sediments associated with river Danube in the southern part of the Great Hungarian plain."⁹

Chile: Health problems related to arsenic in drinking water was first recognized in Northern Chile in 1962. Typical skin pigmentation, skin cancer, cardio vascular problems and respiratory disease. More recently, arsenic ingestion has been linked to lung and bladder cancer. "It has been estimated that around 7% of all deaths occurring in Antofagasta between 1989-1993 were due to past exposure to arsenic in drinking water at concentration of the order of 500ug/L."⁹

Argentina: The Chaco-pampean plain of central Argentina constitutes perhaps one of the largest regions of high arsenic ground waters known, covering around one million square kilometer. "High concentrations of arsenic have been documented from Cordoba, La-Pampa, and Santafe and Buenos Aires provinces. Symptoms typical of chronic arsenic poisoning, including skin lesions and some internal cancers, have been recorded in these areas."⁹

South-Western U.S.A.: Many years have been identified in the U.S.A. with arsenic problems in ground water. "Most of the worst affected and best documented cases occur in the south-western states (Nevada, California, Arizona). However, within the last decade, aquifers in Maine, Michigan, Minnesota, South Dakota, Oklahoma, and Wisconsin have been found with concentrations of arsenic exceeding 10ug/L."⁹

United states: Arsenic contamination from mining activities has been identified in numerous areas of the USA. "Ground water from some areas has been reported to have very high concentration locally (up to 48,000ug/L). Well-documented cases of arsenic contamination include the Fair Banks, gold mining districts of Alaska."⁹

Ghana: Several workers have the effect of mining activity on the environment in Ghana. "The most important mining area is the Ashanti region of central Ghana. Around the town, high concentrations have been noted in the soils close to the mines and treatment works."⁹ Some high concentrations have also been reported in river water close to the mining activity.

Thailand: Probably the worst recorded cases of arsenic poisoning related to mining activity is that of Ronphibun district in Nakhen Si Thammarat province of southern Thailand. Health

problems were first recognized in the area in 1987. "Around 1000 people have been diagnosed with arsenic related skin disorders, particularly in and close to Ron phi bun town. The affected area lies within the south – east Asian Tin belt. Arsenic concentration has been found at up to 5000ug/L in shallow ground water. " 9

Bangladesh:

The country facing what has been described as the largest mass of Poisoning in history. Groundwater, the main source of drinking water is suspected to be contaminated by naturally occurring arsenic in 59 out of Bangladesh's 64 districts and an estimated 20 million out of Bangladesh's 127 million people are at risk. We must never lose sight of the people who are being exposed to arsenic-contaminated water everyday or those who are suffering from arsenic poisoning. We must take action and learn while doing," said Mohsin Alikhan, Acting World Bank Country Director for Bangladesh.

"In Bangladesh, realization is gaining ground that rainwater harvesting is a sustainable solution to combat arsenic polluted groundwater of 59 out of its 64

Districts. The government has decided to launch a nationwide campaign to not only do rainwater harvesting but more significantly, to change people's negative Attitudes towards its use.

" Alarm bells had begun ringing as far back as 1993 when the arsenic contents in groundwater were found to be higher than the permissible limit of 0.05 mg/l. The problem became worse as the presence of an unacceptable level of arsenic did not superficially alter the taste, color or odor of water. Moreover, arsenic poisoning, which only affected people with poor nutrition, take several years to be detected and by then had already become life threatening. Although the genesis of the contamination is yet to be fully comprehended, natural weathering of subsurface soil is being cited as the sole contributor. Presently, deep aquifers are free from arsenic." 11

India: "Prevalence of Arsenicosis in India was 15.02%. " 16

Nepal: Terai region of Nepal has similar Geology to Bangladesh and India.

- Estimated 11 million people in Terai are getting water from 200000 wells. (DWSS, ENPHO 2002)

Table: 1.1 Maximum arsenic concentration detected in Terai districts

SN	District	Maximum arsenic Concentration Detected
1	Rupandehi	303 $\mu\text{g/L}$
2	Nawalparasi	205 $\mu\text{g/L}$
3	Bara	102 $\mu\text{g/L}$
4	Bardia	160 $\mu\text{g/L}$
5	Parsa	158 $\mu\text{g/L}$
6	Rauthat	146 $\mu\text{g/L}$

Source (Situation Analysis Environmental health in Nepal 2002)

- Four most affected districts are Nawalparasi, Parsa, Bara, and Rautahat in Nepal.
- 14450 tube-wells were tested in Terai (1999-2000 A.D.), revealed 28% tube wells had > WHO guide line value (10 $\mu\text{g/L}$) and 5% tube wells had > India, Bangladesh and interim Nepal (50 $\mu\text{g/L}$) standard.
- Prevalence of arsenicosis in Nawalparasi was 5.1% (observed sample population (855), drinking water concentration >50 $\mu\text{g/L}$ (16)
- More than 20% of adult population in Kunwar village of Nawalparasi had arsenic symptoms and arsenic level in water was found >500 $\mu\text{g/L}$ (16)
- In the district of Nawalparasi, Rautahat and Kailali 10-18% samples were above 50 $\mu\text{g/L}$ and concentration was 161 to 571 $\mu\text{g/L}$ (16).
- In Sarawal and Kunwar VDC of Nawalparasi district very high proportion of tube wells were contaminated with arsenic of more than 500 $\mu\text{g/L}$ (16).

Table: 1.2 Arsenic concentrations in different VDC of Rautahat

S N	V.D.C. with high level of arsenic	Sample taken	> 50ug/L
1	Sangrampur	34	26 (76.5%)
2	Rampurkhap	44	28 (64%)
3	Jokaha	40	20 (50%)
4	Sakhua Damaura	41	12 (29%)

Source: NRCS, Samples updates, Rautahat (2002)

2.4 Arsenic Removal Technique

1. Black mixture

"Two-pitcher filter was used as one of the alternative measures to get rid of arsenic problem. Before using the filter, the water is mixed with black powder containing the mixture of activated charcoal, Ferric Chloride (FeCl_3) and Sodium hypochlorite (NaOCl). The mixture of the powder helps to precipitate arsenic and by agitation of the solution two or three times makes the floc of arsenic bigger and help to settle and adsorbed on activated charcoal. Let the solution settle for at least 45 minutes and the supernatant is poured into the filter and precipitate is discarded into cow dung, which help to diffuse arsenic into the atmosphere."¹⁵

2. Three pitcher Method

"The first pitcher contains iron chips and coarse sand second pitcher contains wood charcoal and fine sand the third pitcher is the collector for filtered water. The arsenic concentration of in influent ranging from 0.08 to 0.1mg/L were found to be reduced to less than 0.01mg/L to 0.03mg/L in the effluent even after six months, without changing the sand media."¹⁵

Chapter III

RESEARCH QUESTIONS AND OBJECTIVES

3.1 RESEARCH QUESTION

1. What is the status of arsenic concentration in drinking water extracted from ground in Rampurkhap V.D.C. of Rautahat district?
2. Whether the risk group and health personnel aware of arsenicosis?

3.2 OBJECTIVES

General objective: - To assess the status of arsenic concentration in drinking water, and awareness of arsenicosis among risk group and health personnel of Rampurkhap V.D.C.

Specific objectives: -

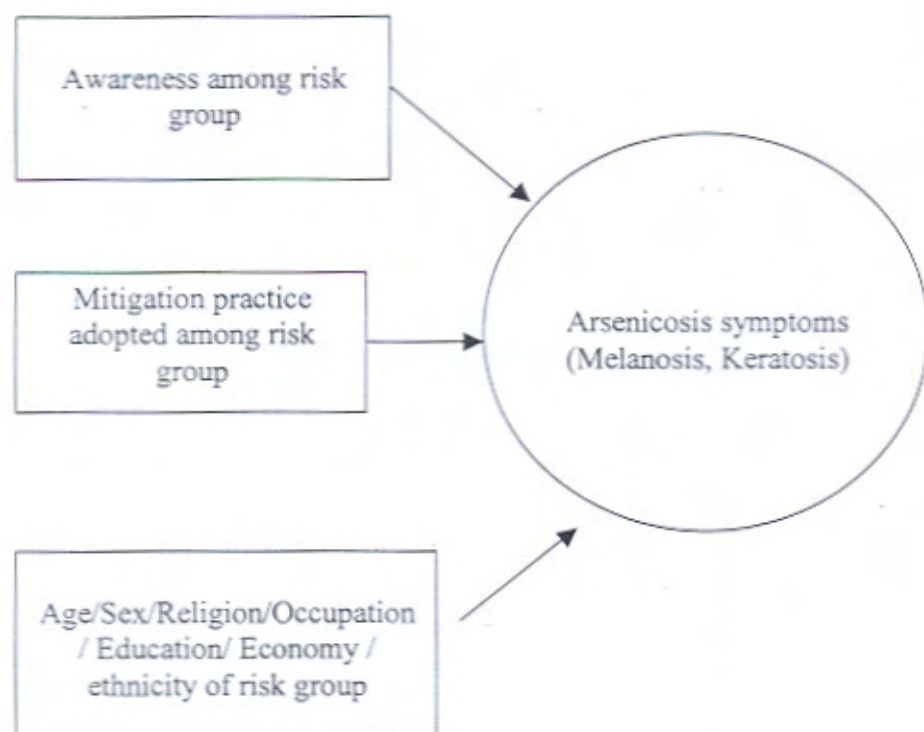
1. To determine the level of arsenic concentration in drinking water
2. To assess the awareness of arsenicosis among risk group.
3. To assess the awareness of arsenicosis among health personnel
4. To identify the prevalence of arsenicosis symptoms and signs among the risk group.
5. To explore the mitigation measures adopted by the risk group and the health personnel

METHODOLOGY

4.1 Study area

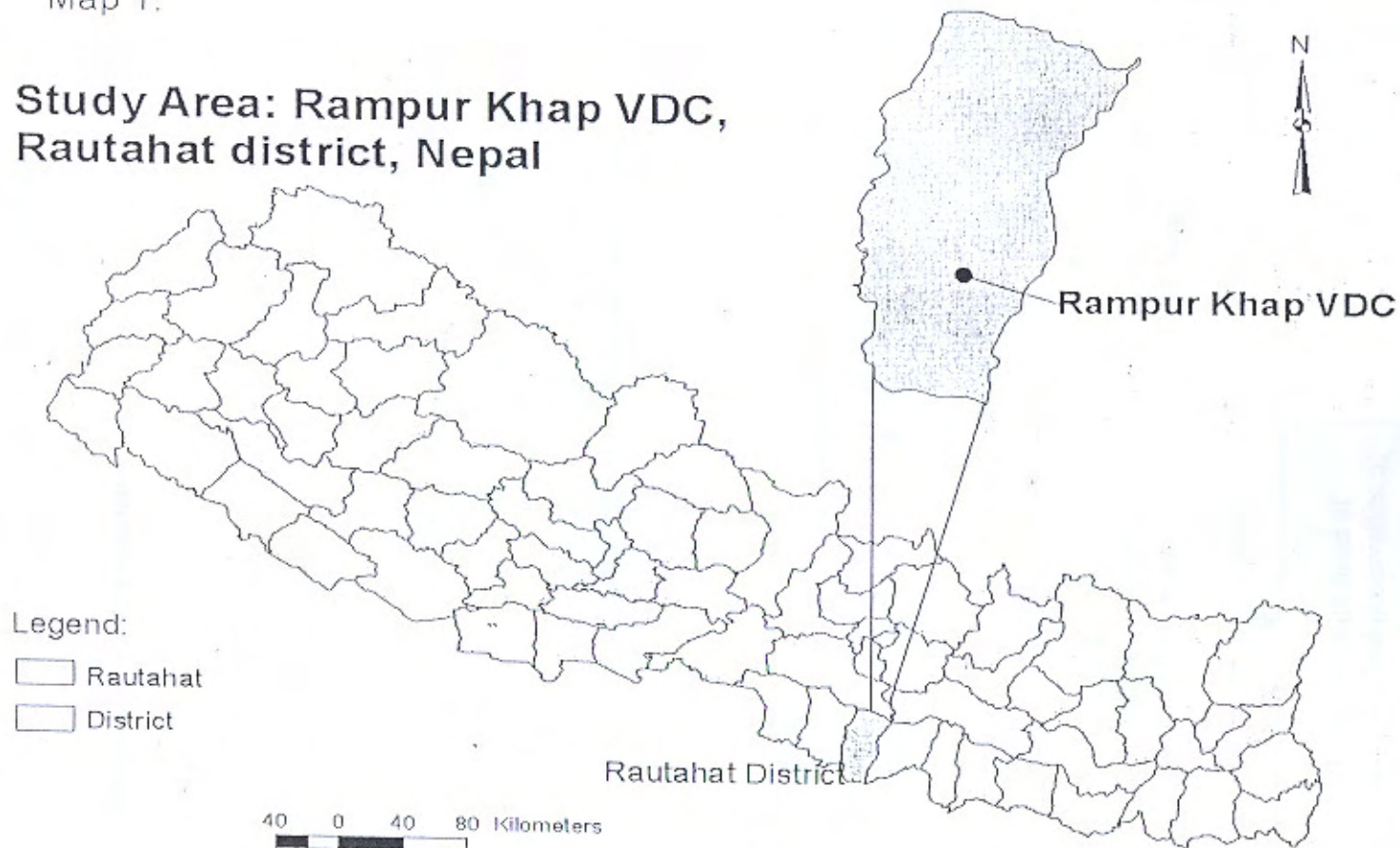
The study area was Rampurkhap VDC of Rautahat district (map 1) of Nepal. It is situated in the west which is 11 kilometer from the district headquarter "Gaur".

4.2 Conceptual Framework



Map 1:

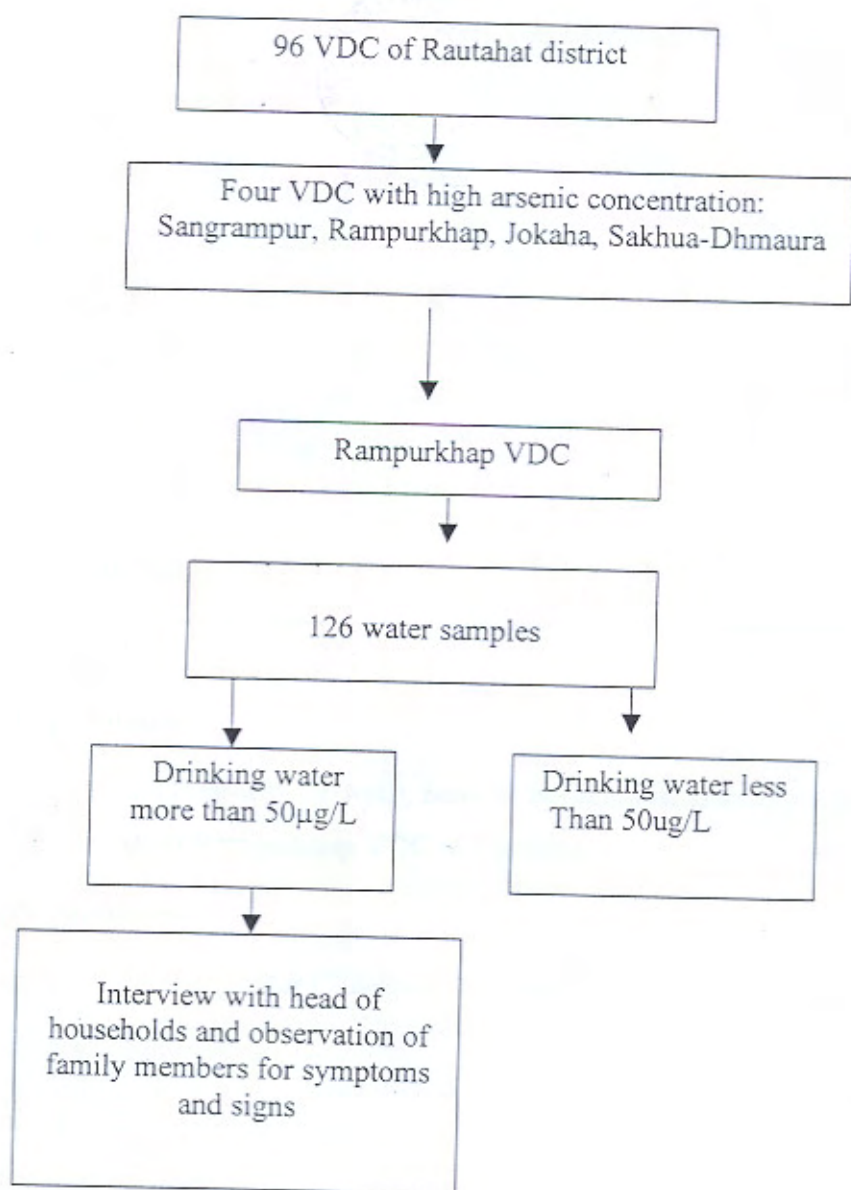
Study Area: Rampur Khap VDC, Rautahat district, Nepal



4.3 Study method This study was based on quantitative method.

4.4 Study design

This was a descriptive cross sectional study of Rampurkhap V.D.C.



4.5 variables

Table 1.3 Independent and Dependent variables.

Independent	Dependent
<ul style="list-style-type: none">▪ Age▪ Sex▪ Religion▪ Ethnicity/ caste▪ Education▪ Occupation▪ Awareness of risk group▪ Mitigation practice	Arsenicosis Symptoms and Signs

4.6 Study population

It was water source (Tube-well or well), head of households, arsenicosis symptomatic patient and health personnel of Rampurkhap VDC of Rautahat.

4.7 Sample population

It was sources of drinking water (Tube-well and well)

4.8 Sampling unit

It was tube-well and well.

4.9 Sampling frame

It was list of water sources (Tube- well or well). There were 220 tube wells and 14 wells. Thus, it became 234.

4.10 Unit of Analysis

Head of households drinking water > 50 µg/L who interviewed. Members of house hold who observed, Sample of water, and health personnel.

4.11 Sample size

It was calculated by formula:

$$n = \frac{4 pq}{L^2}$$

$p = 76\%$ (Arsenic concentration in drinking water, source: (NRCS 2002.)

$q = 24\%$, $L = 10\%$ of p .

$$n = 4 \times 76 \times 24 / 7.6 \times 7.6 = 126$$

4.12 Sampling Technique

Random sampling of water source (tube- well and dug wells) was done by lottery method to test the water for arsenic concentration.

4.13 Instrumentations

Following instruments were used for data collection.

- (a) Questionnaire
- (b) Observation checklist and
- (c) Field-test kit from ENPHO.

4.14 Exclusion criteria

1. Guests of household were excluded.
2. Members of household who were not available at the time of survey were excluded.

3. Age below 2 years children was excluded because of developing arsenicosis; it takes 2-10 years exposure of more than 50µg/L of drinking water.
4. Members of household not living more than 2 years from the date of survey was excluded

4.15 Inclusion criteria

A person from outside living in the household more than 2 years from the date of survey (e.g. servant) will be included. It also included the water sample tested by other agency in 2002.

4.16 Indicators

$$1. \text{percentage of water source with risk level} = \frac{\text{No. of water source} > 50 \mu\text{g/L} \times 100}{\text{Total No. of water sample examined}}$$

$$2. \text{percentage of respondent aware of problem} = \frac{\text{No. of HH aware of problem} \times 100}{\text{Total number of HH interviewed}}$$

$$3. \text{percentage of HH practicing mitigation} = \frac{\text{No. of HH practicing mitigation} \times 100}{\text{Total number of HH observed}}$$

$$4. \text{percentage of HP aware of arsenicosis} = \frac{\text{No. of HP aware} \times 100}{\text{Total number of HP interviewed}}$$

$$5. \text{Percentage of HP practicing mitigation} = \frac{\text{No. of HP practicing mitigation} \times 100}{\text{Total No. Of HP observed}}$$

$$6. \text{Percentage of person with symptom/sign} = \frac{\text{No. of person with symptom/sign} \times 100}{\text{Total number of person observed}}$$

Note: HP = Health personnel, HH = Head of Household

4.17 Data collection method

Data were collected from head of household by interviewing and observation

4.18 Data collection procedure

A preliminary survey was done to find the list of drinking water source and the number of households drinking from it. There were 220 tube-wells and 14 wells altogether 234 source of water for drinking. A total of 123 tube-wells and 3 wells were selected randomly by Lottery method and water sample was tested by field kit method. Out of 123 tube wells, NRCS Rautahat already tested forty-four tube wells in 2002. Four previously tested water source by NRCS Rautahat was re-examined for cross-checking and similar result was obtained.

Pretest of structured questionnaire and observation checklist was done in Dumaria VDC near Rampurkhap VDC and necessary correction was made. Two interviewers one male and one female were selected and trained how to get information from the respondents and how to fill the questionnaire forms. The interviewers collected information from the available respondents (head of households) who were drinking water from the tube wells with arsenic concentration of more than $50\mu\text{g/L}$. All the health personnel working in different levels of the VDC were also interviewed to know their level of awareness regarding arsenic and Arsenicosis. The researcher closely monitored the interviewers and observed and examined symptomatic cases of arsenicosis. The researcher got one day training in ENPHO laboratory to test arsenic concentration in drinking water and then tested water samples in Rampurkhap. Five samples from 82 sample tube wells were re-examined by the field worker of district Red cross office, Rautahat for cross checking the reliability of the tested samples by researcher.

4.19 Sample test procedure

ENPHO field test kit was used to test the sample from drinking water sources. The test kit consists of mercury bromide (HgBr_2) coated paper and, lead acetate, zinc dust and Hydrochloric acid (HCl). The test kit is filled with 20 ml of water sample and sodium bromide solution. Within 10 minutes arsenic gas produces and changes the color of the HgBr_2 coated indicator paper. The concentration of arsenic in the sample water can be estimated by comparing the color change observed on the HgBr_2 indicator paper used with that of standard color matrix.

4.20 Ethical consideration

The respondent was informed about the purpose and the procedure of the study. The interview was performed after their verbal approval. Privacy and confidentiality of all information was maintained. They were informed about arsenic concentration of their water and preventive measures. One-day orientation about arsenicosis was conducted for female health volunteers of the community to make aware the people.

4.21 Data processing and Analysis

After completion of data collection, data was checked and edited. The coding was done for entry in Epi-Info-6 and Excel after sorting of the data. Again, the entered data was verified with the questionnaire to find out the entry mistake. The entry mistake was checked by making check file. The data was stored in the hard disc and in the floppy disc. Frequency tables, cross tables, bar diagrams, and line charts were prepared. Statistical tools e.g. proportion, rates, ranges were calculated.

4.22 Validity and Reliability

The employed, oriented and trained personnel collect the data. During data collection, all the enumerators was monitored and supervised by the investigator. All forms were checked for completeness and accuracy. Repeated visit was arranged to meet the respondents if needed. Five samples of water were retested by Field worker of district red cross office and similar result was obtained. Crosschecking of the samples, which were already tested by NRCS Rauthat and were not found variation in the concentration of arsenic in sample water.

4.23 Operational definitions

Age: - It will be enumerated in completed years.

Sex: - Male or Female of household.

Economic status: - It was classified into poor, middle and rich.

Poor : House holds having less than one bigha of land.

Middle: Household having one to five bighas of land.

Rich : Household having more than five bighas of land.

Education: - It was divided into illiterate and literate.

Illiterate: Those who cannot read and write.

Literate: Those who can read and write.

Primary level: Those who have education up to class five education.

Secondary level: Those who have education of class six to S.L.C.

Higher level: Those Who have education of intermediate and above.

Occupation: It was farmer, housewife, service, labor, and businessman.

Ethnicity/ Caste: It was defined and classified according to population Monograph 2001 and community.

Health Personnel: They were AHW, VHW, MCHW, FCHV and TBA working in Rampurkhap VDC.

Keratosiis: Dermatitis with or without follicles or formation of bullae or folliculitiis on Sole and palm.

Melanosis: Rain drops pigmentation or molted brown pigmentation of the skin or black spot or whole skin black or white spot or whitish discoloration of skin on trunk, Sole and palm.

Awareness: Ability to report at least one symptom melanosis, keratosiis or both or arsenic is a slow poison and describe about two or three pitcher filter.

Mitigation practice: Filtering of drinking water by 3-pitcher method, which contains pieces of brick, small pieces of iron, sand and coal or two-pitcher filter given by N.R.C.S.

Risk group: Members of household consuming drinking water more than 50ug/L concentration of arsenic.

Risk level: Concentration of arsenic >50ug/L of drinking water.

4.24 Limitation of the study: The study was limited among the people of one V.D.C., so it might be or might not be generalized.

FINDINGS

5.1 General characteristics of respondents

Out of 145 respondents were classified in six groups. The highest numbers were of age group 40-49 years (29%) followed by age groups of 30-39(26.9%), 20-29(17.2%), 50-59 (13%), 60-69 (11.7%) (Table 1.4). The least number of respondents were in age group 70-79 years. In sex-wise distribution of respondents, 103 (71%) were male and 42 (29%) were female. Likewise the majority of the respondents were Hindu (53.8%) and rest was Muslim (46.2%). However, the respondents belonged two types of religions but they had different ethnicity/caste. The major ethnicity/caste were Muslim, and among Hindu different castes were Patel/Raut, Das, Shah, and others(Mahra, Sahni and Mahto yadav).

Table 1.4 Distribution of respondents by age, sex, religion and ethnicity/caste

Age group	Number	Percent
20-29	25	17.2
30-39	39	26.9
40-49	42	29.0
50-59	20	13.0
60-69	17	11.7
70-79	2	1.4
Total	145	100
Sex	Number	Percent
Male	103	71
Female	42	29
Total	145	100
Religion	Number	Percent
Hindu	78	53.8
Muslim	67	46.2
Total	145	100
Caste/Ethnicity	Number	Percent
Muslim	67	46.2
Patel/Raut	21	14.2
Das	19	13.1
Shah	14	9.6
Mahra, Sahni, Mahto, Yadav	24	16.6
Total	145	100

Source: Field survey (2003)

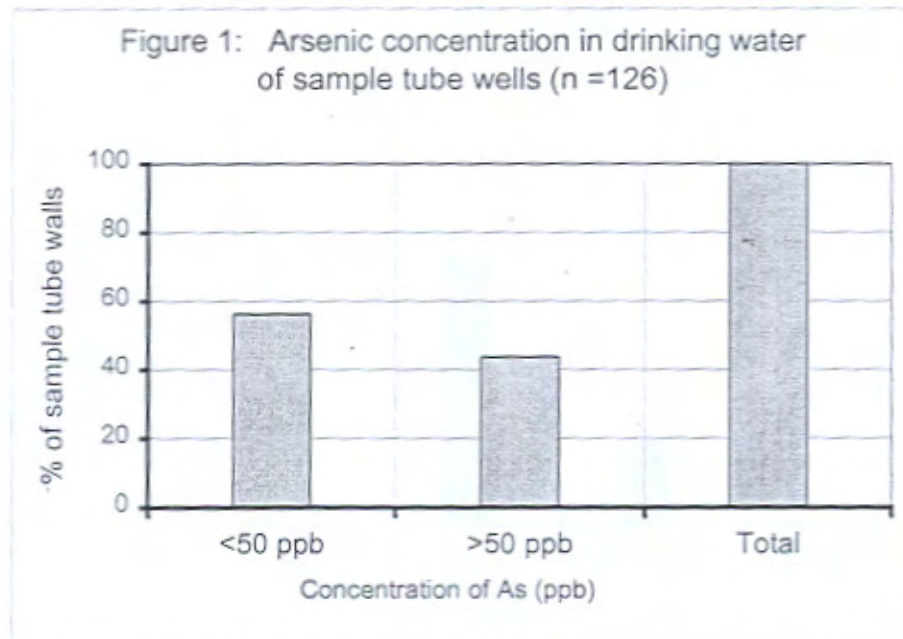
Out of 145 respondents 103 (71%) were illiterate, 10 (6.8%) were just literate, whereas 13 (9%) were having primary education, 17 (11.7%) were of secondary level (Table 1.5). In occupational character of respondents out of 145 respondents 70 (48.3%) were farmer followed by 69 (47.6%) was labor. Economically 107 (73.8%) respondents were poor followed by 33 (22.8%) middle and very few 5 (3.4%) rich (Table 1.5).

Table 1. 5 Education, occupation and economic status of respondents

Education	Number	Percent
Illiterate	103	71.0
Literate	10	6.8
Primary	13	9.0
Secondary	17	11.7
Higher	2	1.4
Total	145	100
Occupation	Number	Percent
Agriculture	70	48.3
Business	1	0.7
Service	5	3.4
Labor	69	47.6
Total	145	100
Economic status	Number	Percent
High (Rich)	5	3.4
Middle	33	22.8
Low (Poor)	107	73.8
Total	145	100

Source: Field survey (2003)

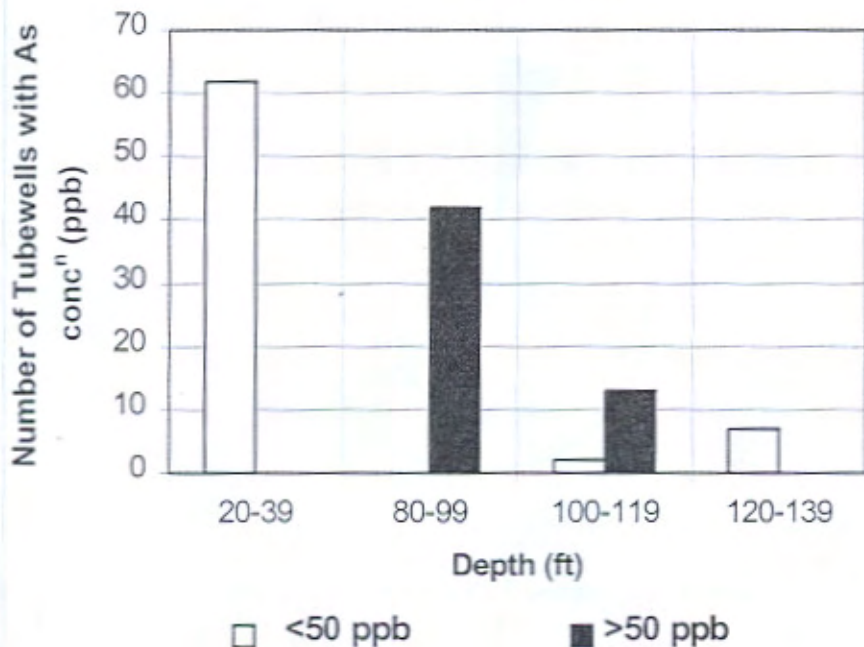
5.2 Distribution of Arsenic concentration in drinking water by risk level



Out of 126 drinking water sources 56.3% of water sample were found below $50\mu\text{g/L}$ and 43.7% samples were above $50\mu\text{g/L}$. Three samples were from old wells which had arsenic concentration of $0\mu\text{g/L}$ (not detectable).

5.3 Distribution of arsenic concentration by depth of wells

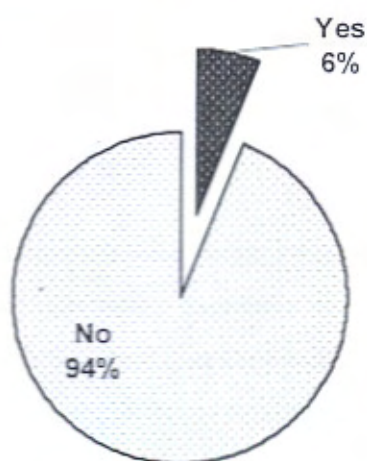
Figure 2: Arsenic Concentration and Depth of the Tube Well (n =126)



Out of 126 tube-wells/wells 62 (49.25%) had depth of 20-39 feet with less than 50 μ g/L followed by 42 (33.33%) had depth of 80-99 feet with concentration of more than 50 μ g/L. In the depth of 100-119 feet, 2 samples were found less than 50 μ g/L and 13 samples were with more than 50 μ g/l. In the depth of 120-139 feet the seven samples had less than 50 μ g/L concentrations.

5.4 Distribution of respondents by awareness of arsenicosis

Figure 3: Awareness of Respondent of Arsenicosis
(n = 145)



Only 6.2% of respondents were aware of arsenic and Arsenicosis. Majority of respondents (93.8%) were not aware (Figure 3).

Distributions of respondents by Source of awareness

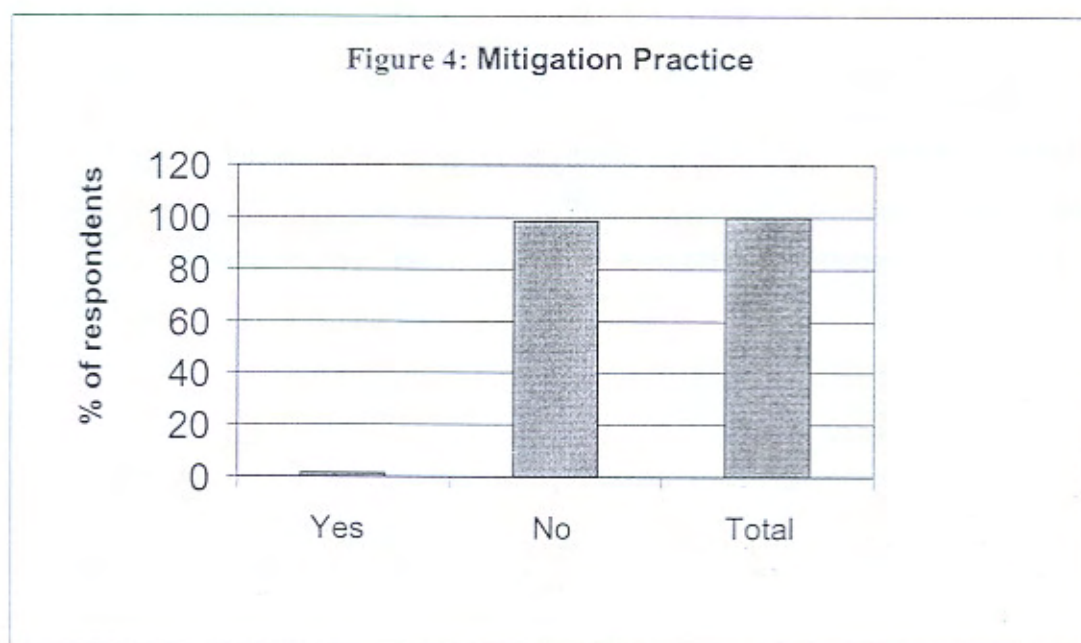
- All 9 respondents who were aware of arsenicosis were informed by health workers of district Red Cross office, Rautahat.

Table : 1.6 Awareness of respondents on types of mitigation measures

Filter	Frequency	%
Two-pitcher method	8	88.9
Three pitcher method	1	11.1
Total	9	100

➤ The total 9 respondents who were aware of arsenic and its related problems were asked about any mitigation measures they know or practice to get rid of arsenic problem. Eight of them told that they were aware of 2- pitcher method of arsenic filter and the last one told about three- pitcher method.

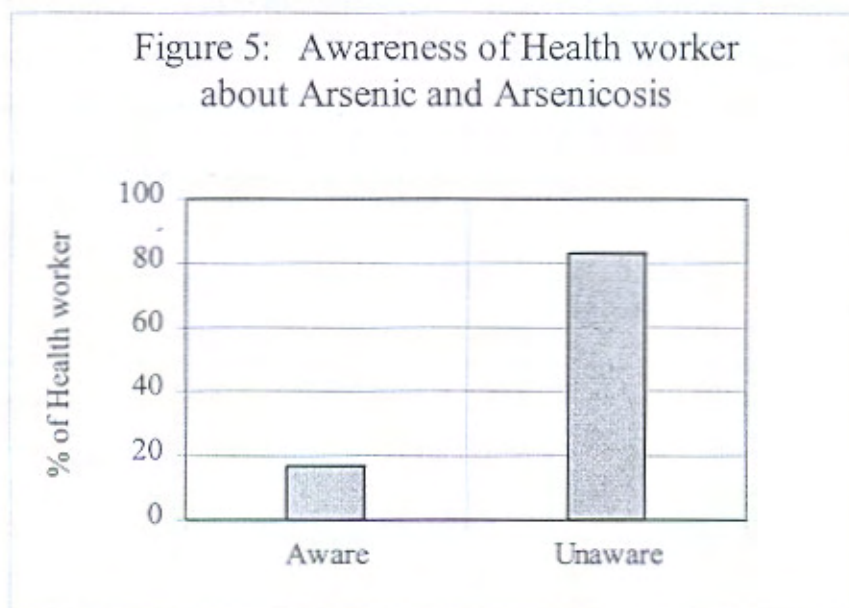
5.5 Mitigation measures adopted by Respondents:



Out of 145 respondents only 2 (1.4%) had adopted mitigation measure.

5.6 Awareness of arsenicosis among health workers

Awareness of arsenic and arsenicosis among health personnel was found very poor. Out of 12 health workers, only 2 (16.6%) were aware of it (Figure 5).



- None of the health workers was adopting any mitigating measures to reduce arsenic concentration in drinking water. Only one of them had tested Arsenic level of his drinking water source and found arsenic concentration within acceptable level.

5.7 Patient with Arsenicosis Sign and Symptom

Out of 126 households 71 households were consuming water with acceptable level of arsenic (<50 ppb) whereas remaining 55 households were consuming arsenic concentration above acceptable level (>50 ppb) and belonged to risk group. All the members of the later group i.e. risk group were further enquired, observed and examined for prevailing Arsenicosis symptoms. There were altogether 1044 members or persons from the risk group and 19 of them showed arsenicosis symptom (Table 1.8).

Table: 1.7 Patients with Arsenicosis Signs and Symptoms

Type	Number	Percent
Melanosis- palm	6	0.57
Melanosis - sole	3	0.28
Melanosis- trunk	2	0.20
Keratosis – palm	3	0.28
Keratosis – sole	2	0.20
Nodules – sole	3	0.28
Total	19	1.81

Source: Field survey (2003)

observed populaion=1044

Out of 19 arsenicosis symptomatic patients melanosis of palm were found the highest 6 (0.57%), followed by melanosis sole 3 (0.28%), Keratosis palm 3 (0.28%), nodules sole 3 (0.28%) and the least were melanosis trunk 2 (0.2%) ,and keratosis sole 2 (0.2%).

5.8 Arsenicosis patients consuming water with arsenic concentration

Table: 1.8 Arsenic concentrations in drinking water consumed by Arsenicosis symptomatic patients

Arsenic concentration ($\mu\text{g/L}$)	Number of patients	Percent
51-100	5	26.3
101-150	7	36.8
151-200	7	36.8
Total	19	100

Majority of arsenicosis symptomatic patients 7 (36.8%) were consuming water with concentration of 101-150 $\mu\text{g/L}$ and another 7(36.8%) patients were consuming water with concentration of 151-200 $\mu\text{g/L}$ and less 5 (26.3%) were consuming 51-100 $\mu\text{g/L}$.

5.9 Arsenicosis patients by duration of consuming water with risk level

Table: 1.9 Arsenicosis symptomatic patient and duration of consuming water with risk level

Types of patient	Duration of drinking in year				
	3-4	5-6	7-8	9-10	Total
Melanosis - Palm	1	3		2	6
Melanosis- sole			1	2	3
Melanosis - Trunk		1	1		2
Keratosis-Palm	1		1	1	3
Keratosis-Sole		1		1	2
Nodules-sole		2		1	3
Total	2	7	3	7	19

Table 1.9 depicts that all the arsenic symptomatic patients were exposed form 3 –10 years. Majority of the patients fall above 5 years of exposure.

5.10 Prevalence of Arsenicosis symptoms and signs among risk group

Point Prevalence of Arsenicosis symptoms and signs = Number of patient of arsenicosis symptoms and signs x 100 during the survey period (2059 Magh 15 to 2059 Falgun 7) /Total member of household observed during survey period.

$$= 19 \times 100/1044$$

$$= 1.81\%$$

5.11 Prevalence of arsenicosis symptoms and signs by age group

Table: 1.10 Prevalence of arsenicosis symptoms and signs by age group

Arsenicosis symptoms and signs					
Age-group	Yes		No		Total
	Number	%	Number	%	
2-9	0	0	459	100	459
10-19	0	0	295	100	295
20-29	0	0	50	100	50
30-39	2	2.56	76	97.43	78
40-49	7	8.33	77	91.66	84
50-59	8	18.18	36	81.81	44
60-69	2	5.88	32	94.11	34
Total	19	1.81	1025	98.18	1044

Source: Field survey (2003)

The prevalence of arsenicosis symptoms and signs was found the highest among age group of 50-59 years (18.18%) followed by 40-49 years (8.33%) and the least were among the age group of 30-39 and 60-69 years (Table 1.10).

5.12 Prevalence of arsenicosis symptoms and signs by gender

Table: 1 1 Prevalence of arsenicosis symptoms and signs by gender

Arsenicosis symptoms and signs					
Gender	Yes		No		Total
	Number	%	Number	%	
Male	8	1.45	540	98.54	548
Female	11	2.21	485	92.30	496
Total	19	1.81	1025	98.18	1044

Source: Field survey (2003)

The prevalence of arsenicosis symptoms and signs was more among female (2.21%) than male 1.45%

5.13 prevalence of arsenicosis symptoms and signs by religion

Table: 1.12 Prevalence of Arsenicosis symptoms and signs by religion .

Arsenicosis symptoms and signs					
Religion	Yes		No		Total
	Number	%	Number	%	
Hindu	8	1.42	553	98.57	561
Muslim	11	2.28	472	97.72	483
Total	19	1.81	1025	98.18	1044

The prevalence of arsenicosis sign and symptoms were found more among Muslim (2.28%) than Hindu (1.42%)

5.14 Prevalence of arsenicosis symptoms and signs by occupation

Table: 13 Prevalence of Arsenicosis symptoms and signs by occupation

Arsenicosis symptoms and signs					
Occupation	Yes		No		Total
	Number	%	Number	%	
Agriculture	11	2.18	493	97.81	504
Business	0	0	7	100	7
Service	2	5.55	34	94.44	36
Labor	6	1.20	491	98.79	497
Total	19	1.81	1025	98.18	1044

The prevalence of arsenicosis symptoms and signs was found highest among service men (5.55%) followed by farmer (2.18%) and labor (1.20%).

5.15 Prevalence of arsenicosis symptoms and signs by economic status

Table: 14 Prevalence of arsenicosis symptoms and signs by economic status

Arsenicosis symptoms and signs					
	Yes		No		
Status	Number	%	Number	%	Total
Rich	0	0	36	100	36
Middle	3	1.26	235	98.73	238
Poor	16	2.07	754	97.92	770
Total	19	1.81	1025	98.18	1044

The prevalence of arsenicosis symptoms and signs as found the highest among poor (2.07%) followed by middle economy (1.26%) and no prevalence was found among rich.

5.16 Prevalence of arsenicosis symptoms and signs by education

Table: 1.15 Prevalence of arsenicosis symptoms and signs by education level

Arsenicosis symptoms and signs					
Level	Yes		No		Total
	Number	%	Number	%	
Illiterate	17	2.28	730	97.72	747
Literate	0	0	70	100	70
Primary	0	0	93	100	93
Secondary	1	0.83	119	99.16	120
Higher	1	7.14	13	92.85	14
Total	19	1.81	1025	98.18	1044

The prevalence of arsenicosis symptoms and signs was found the highest among illiterate (43.94%) followed by higher education (7.14%) and the least among secondary level (0.83%).

5.17 Prevalence of arsenicosis symptoms and signs by ethnicity / caste

Table: 1.16 prevalence of arsenicosis symptoms and signs by ethnicity/caste

Arsenicosis symptoms and signs					
Ethnicity/ Caste	Yes		No		Total
	Number	%	Number	%	
Muslim	11	2.3	472	97.7	483
Shah	2	2.1	91	97.9	93
Raut/Patel	2	1.4	139	98.6	141
Das	2	1.2	166	98.8	168
Others	2	1.2	157	98.8	159
Total	19	1.8	1025	98.2	1044

Others= paswan, Mahra, sahni, yadav.

The prevalence of arsenicosis symptoms and signs among Muslim was found highest (2.3%) followed by Shah (Teli) 2.1%. It was 1.4% among Raut/Patel and the least prevalence was found among Das 1.2% and others 1.2%.

5.18 Prevalence of arsenicosis symptoms and signs by awareness

Table: 1.17 Prevalence of Arsenicosis symptoms and signs by awareness

Awareness	Yes (Arsenicosis)		No (Arsenicosis)		Total
	Number	%	Number	%	
Aware	1	1.58	62	98.4	63
Unaware	18	1.83	963	98.16	981
Total	19	1.81	1025	98.18	1044

The prevalence of arsenicosis symptoms and signs was found more among the risk group who had not awareness (1.83%) followed by 1.58% who was aware.

- Only 2 households had adopted mitigation measure (two- pitcher filter) for 4 months.

Summary of finding

- Awareness regarding arsenicosis among people of Rampurkhap was very low (6.2%).
- Very few people had adopted mitigation measures (1.4%).
- 43.7% samples of drinking water of the VDC were above risk level.
- Only 16.6% of health personnel were aware of arsenicosis.
- No any health workers had adopted mitigation measure.
- The prevalence of Arsenicosis symptomatic patients was 1.8% in Rampurkhap VDC.

Discussion

Arsenic contamination in drinking water has been a global concern. It has affected many countries of the world for example South Africa, America, Chile, Ghana, Mexico, China, India and Bangladesh. In south Asia region India and Bangladesh are badly affected. In 1998, Bangladesh had announced that Arsenicosis as one of the biggest epidemic of the world. The Terai region of Nepal has similar geography to India and Bangladesh and similar practice of extraction of ground water for drinking. Therefore, contamination of ground water with arsenic and prevalence of arsenicosis might be similar.

This study found the arsenic concentration exceeding more than $50\mu\text{g/L}$ in 43.7% of total sample tube-wells in Rampurkhap V.D.C. of Rautahat district. According to Department of Public Health Engineering, Bangladesh tested 80,000 tube-wells water from various sites of the country and found 50% of tube-wells were contaminated with arsenic concentration of more than $50\mu\text{g/L}$. Department of occupational and environmental health of Bangladesh tested 12000 tube-wells and found 42% were detected with arsenic more than permissible level (The Daily Janokantho a Bangla News Aug.2001) This study found 43.7% of samples of tube-wells of Rampurkhap V.D.C. having concentration of arsenic more than $50\mu\text{g/L}$ which is similar to the study of Bangladesh. This study also found that concentration of arsenic in drinking water varies from tube well to tube well which ranges from 0 (not detectable) to $213\mu\text{g/L}$. But in Kunwar and Sarawal VDC of Nawalparasi district had $500\mu\text{g/l}$.

In Nepal, a study from ENPHO, 5% samples reported to have arsenic concentration more than $50\mu\text{g/L}$ out of 14,865 samples collected from different district of Terai (DWSS may, 2002). According to Nepal Red Cross society (2002), maximum contamination 76.5% of tube wells were reported more than $50\mu\text{g/L}$ of arsenic concentration in Sangrampur V.D.C. of Rautahat district. According to Department of Environmental and Occupational health, Bangladesh and National Institute of Preventive and Social Medicine, the prevalence of arsenicosis was 10% in Bangladesh.

In Nepal, prevalence of arsenicosis was found 1.3% to 5.1% in Terai district (Shrestha M.P., Shrestha R, R, et al. 2002). This study also found the prevalence of arsenicosis signs and symptoms was 1.81% in Rampurkhap VDC of Rautahat.

The prevalence rate of arsenicosis is less than that of Nawalparasi district, which might be due to the average range of concentration in water is lower in this VDC than Nawalparasi. It might be affecting dose response and other factors like nutrition status, immunity of people etc.

In Bangladesh, a study (by Sk. Akhtar, Don Bandranayke et al. 1999) found that female patients were more common than male. In this study prevalence of arsenicosis among female were found (2.2%) which was higher than male (1.45%). It might be due to high frequency of childbirth causing anemia and poor nutrition. Similarly prevalence of arsenicosis among poor was found 2.07%, which might be due to not getting nutritious food. Prevalence of arsenicosis among illiterate people was found 2.27%. Prevalence of arsenicosis among people who were aware was found 1.58%, which was lesser than those who were not aware (1.83%). One study carried out in Bangladesh, showed that the farmer and agricultural labor were suffered most (Sk. Akhter et al, 1997). Similarly this study found that the prevalence of arsenicosis among farmer was 2.18% and among labor was 1.2%, which was higher. Among service men prevalence of disease was found 5.5%, which was the highest among occupational group. It might be due to small number of sample.

In Bangladesh, a study (Sk. Akhtar Ahmad et, al, 2001) found that arsenicosis patients were drinking arsenic contaminated water for 5-10years. Similarly, this study found that all arsenicosis symptomatic patients were drinking for 3-10 years. According to the study by ENPHO (Shrestha RR, Shrestha MP et al.) carried out in Nawalparasi and Bara districts showed that prevalence rate of arsenicosis tends to increase by age in all study areas, similarly this study also found that most of the patients were age of 50-59 years (18.18%) followed by 60--69 years age (5.9%). This study is showing that higher proportion of disease was among older population.

This study was first attempt in Nepal, to find out the awareness of community people about arsenic in drinking water and its effect on health"arsenicosis symptoms and signs" and also awareness among health workers working in arsenic contaminated community of Terai. The study found only 6.2% of respondents were aware of arsenicosis. The study revealed that only 16.7% of health workers were

aware of arsenicosis. The study found only 1.4% people were adopting mitigation measures and no any health workers had adopted mitigation measure.

Chapter VII

Conclusions

All the households have consumed drinking water from two major sources such as tube wells and dug wells. Though the prevalence rate of arsenicosis was low, the proportion of risk group was very high. The awareness of community as well as health personnel in terms of arsenic and arsenicosis was low. This indicates an awful and alarming situation. This warrants that the problem should be taken seriously. It was found that arsenicosis symptoms have occurred in poor communities, which might be due to poor nutritious foods and poor socioeconomic status. It was also found that most of the persons having arsenicosis symptoms were poor and illiterate. Number of females having arsenicosis symptoms had exceeded over male number. Any mitigation program of arsenic problems to be undertaken in future should target over the poor, illiterate and female populations.

Recommendations

- Because the study found that 43.7% of water sample was above risk level, therefore it should be considered as a grave health problem of community and safe water should be supplied.
- Sustainable provision should be made to test arsenic concentration from all the sources of drinking water before consumption.
- Awareness program on arsenicosis should be implemented in community.
- Mitigation practice should be encouraged in the community (for example two-pitcher filter, 3- pitcher filter and sanitary ventilated wells).
- All the health personnel including female community health volunteers working in the community should be trained regarding arsenic and its consequences and mitigation measures

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30037 : **Questionnaire:**

1. I.D. #

Date: _____

2. Head of household

3. Age:

4. Sex:

5. Address:

6. # of household's member

7. Ethnicity/ Caste:

8. Occupation:

9. Economic status:

10. Education:

Illiterate

Literate

Primary

Secondary

Higher

11. Source of drinking water:

Well

Tube well

Pipe

River

12. From how long do you consuming water from the source?

Year

13. Do you Know about arsenicosis ?

Yes

No

14. If yes, what are they?

Melanosis

Keratosi

Both

15. From where do you get this information?

Radio

Television

Health worker

Teachers

Neighbor

Friend

16. If any member of house is suffering from melanosis or keratosi?

Yes

No

17. Do you do mitigation of arsenic from drinking water?

Yes

No

For health workers:

1. Do you know about arsenicosis?

Yes

No

2. If yes what are they?

Melanosis

Keratosis

Both

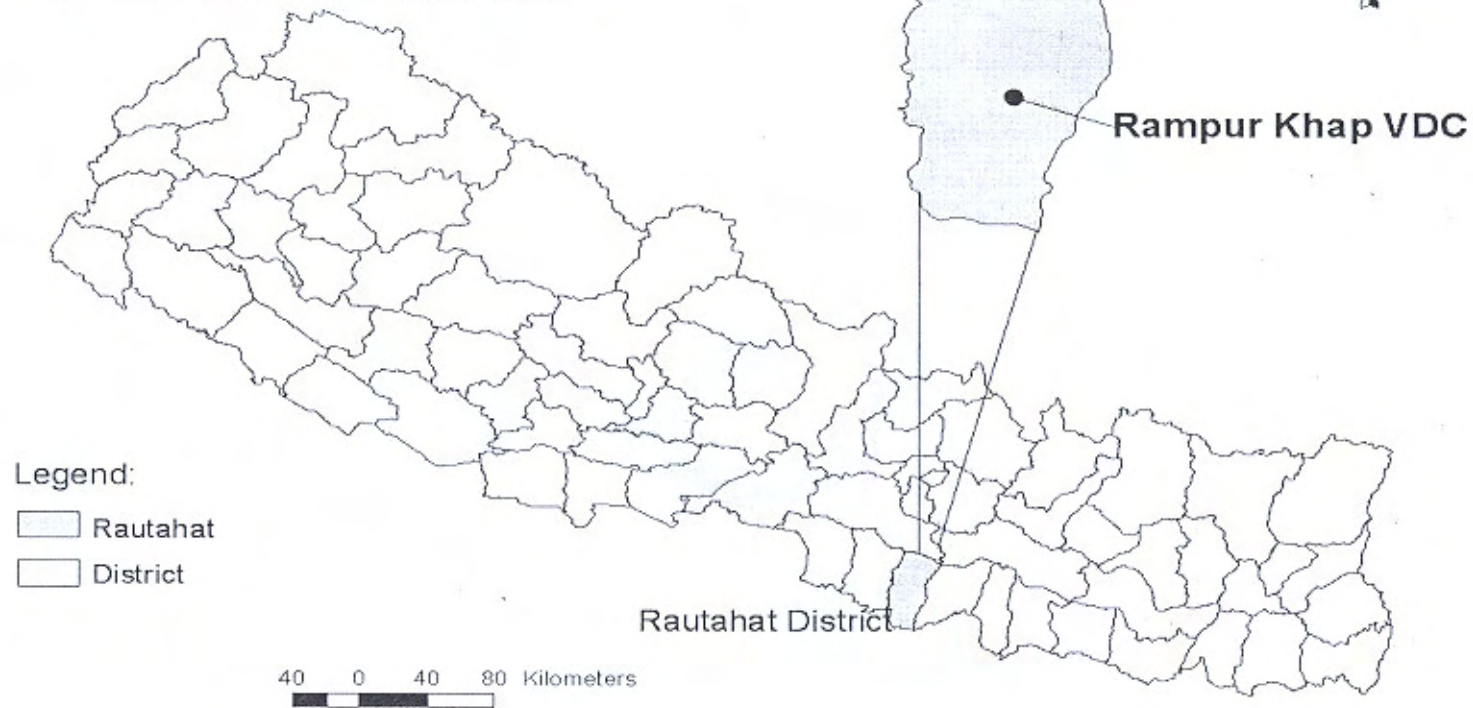
3. If yes, do you educate people?

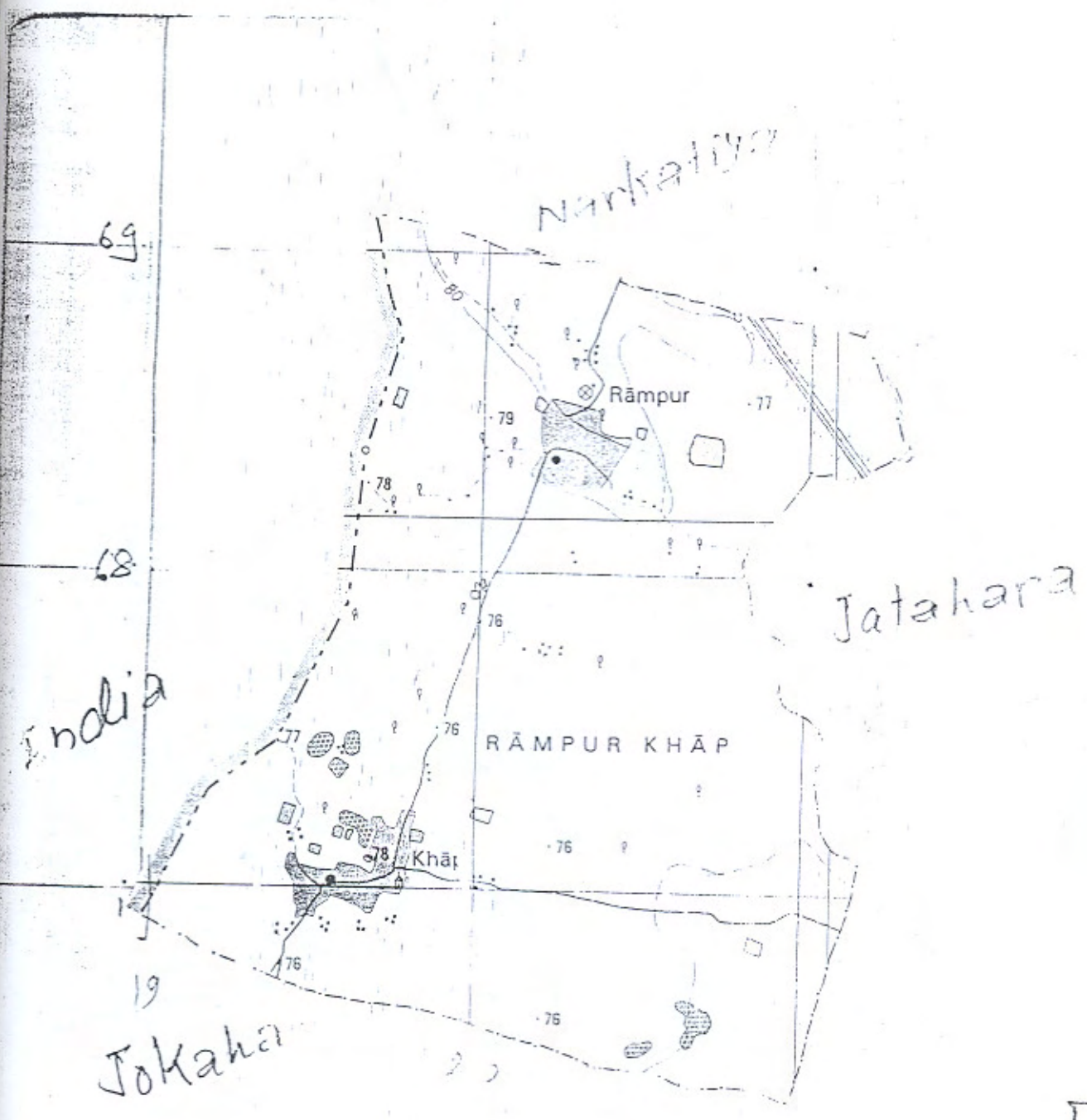
Yes

No

Map 1:

Study Area: Rampur Khap VDC, Rautahat district, Nepal

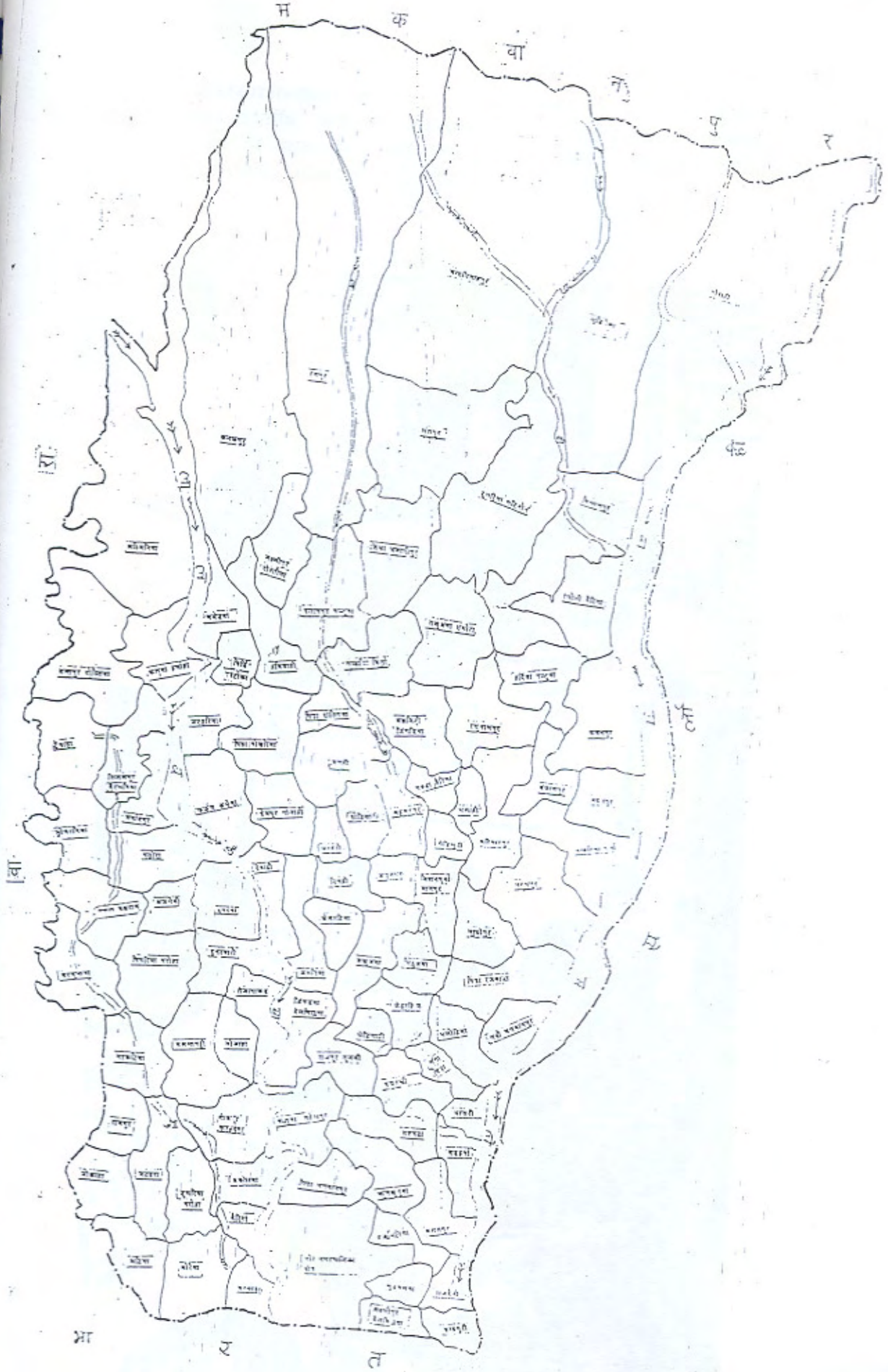




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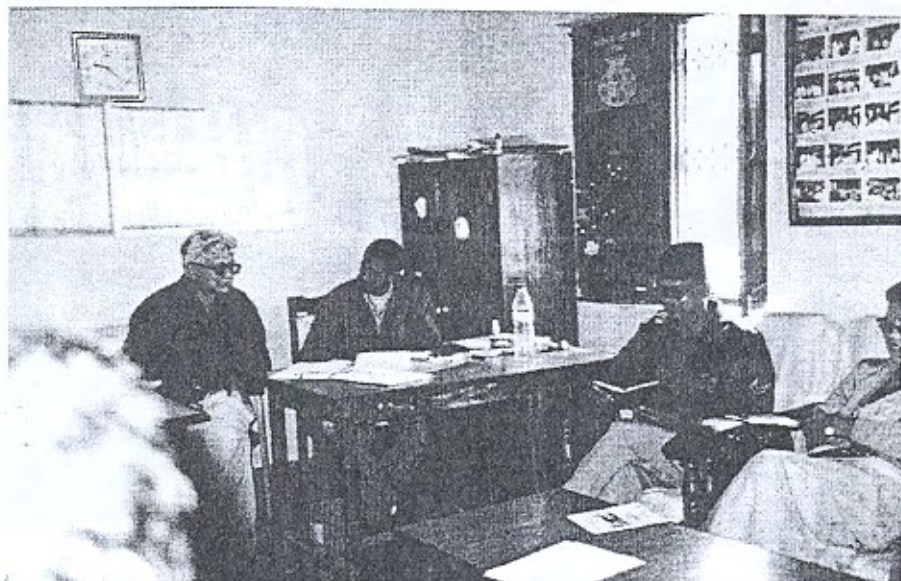
रामपुर खाप गा. वि. स.

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रायचूर जिला

A dissemination meeting amidst health experts, Red Cross staffs, social workers regarding problems and status of arsenic and mitigation measures in Gaur municipality, Rautahat District

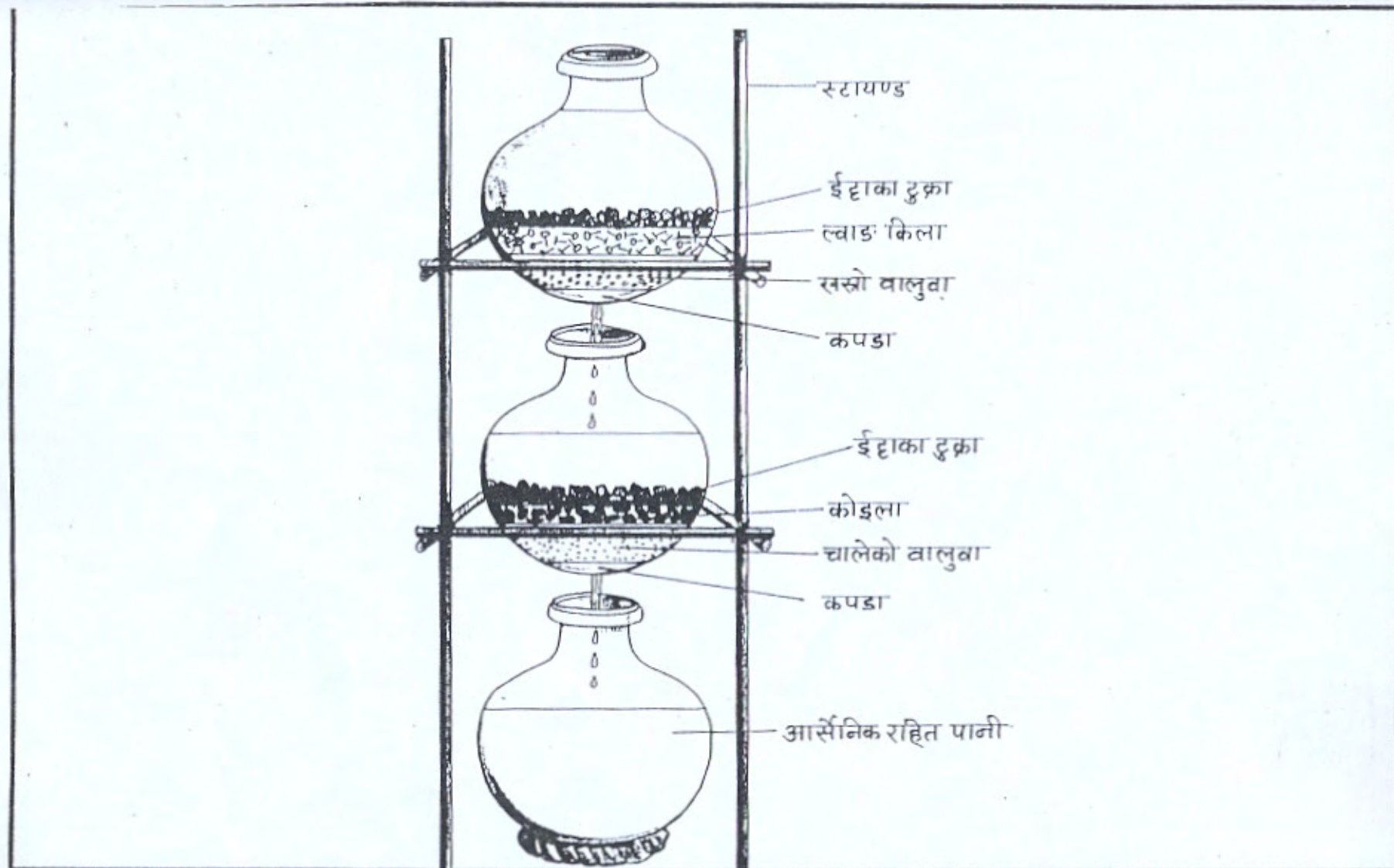




A patient with Keratosis on sole



Awareness programme on Arsenicosis to Female Volunteers



Three Picture Method of Arsenic Removal Filter from Arsenic Contaminated Water.