Arsenic Contamination in Drinking Water in Kachua Upazila of Chandpur District: Problems and Programs for its Remedy.

Golam Rahman*
M.A. Matin Miah*

Abstract

The paper aims at understanding the arsenic contamination of drinking water in Bangladesh and attempts to show the extent and depth of this catastrophe. About 57 million people (out of the total population of 140 million) are in the grip of arsenic contamination from shallow tube wells originally installed for overcoming the shortage of drinking water. The nature and extent of arsenic contamination in rural villages, where about 76% people are living depending on the supply of tube well water from shallow aquifers, which have been known to be arsenic contaminated, seem severe. According to the latest survey information of the government and non-government organizations about 53 districts out of 64 in Bangladesh are marked as arsenic contaminated areas, whose total land area is about 87390 sq. km. It is revealed that, up to 57 million people in Bangladesh alone more than the number worldwide infected with HIV virus are at risk of debilitating diseases or death from long term affects of drinking arsenic contaminated water. Hence, a treatment process and programs to remove arsenic from water along with other available local options should be encouraged which will ensure mitigation of arsenic problems. All possible options have to be adopted to save the life of the people in the affected areas for sustainable rural community living environment.

Key words: Arsenic Contamination, Arsenic Concentration, Arsenicosis, Water options, Pond Sand Filter and other options etc..

1. INTRODUCTION

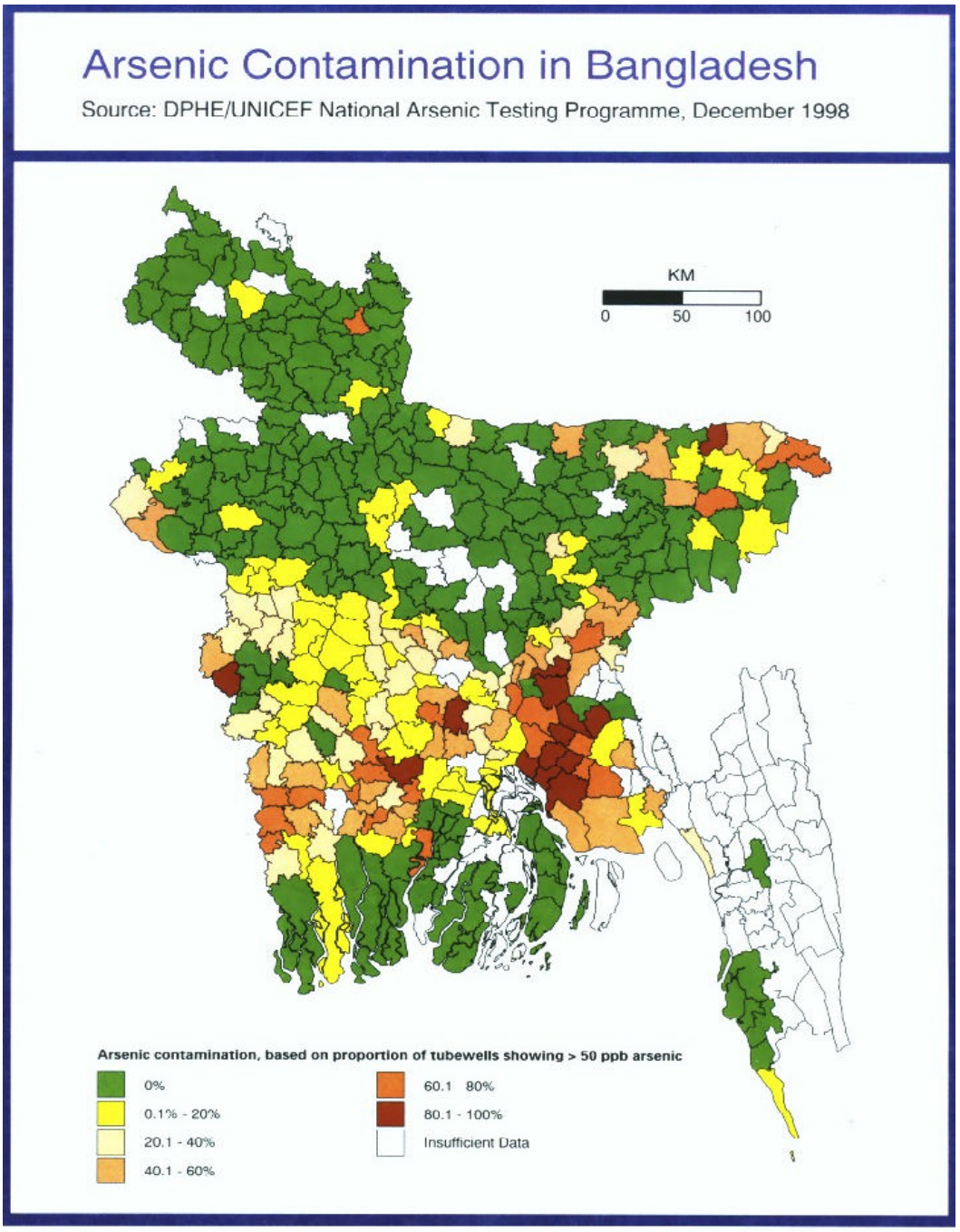
Bangladesh, a very densely populated country prone to natural disasters (flood, cyclone, and drought), has been hit by another environmental catastrophe in recent years. The problem is new in Bangladesh and little is known about the cause, effect on health, and means of mitigation. According to the various research reports, the actual proportion of the population exposed to the risk may be 57 million (using a drinking water standard of 50 ppb). The WHO established 10 ppb as a Provisional Guideline Value for arsenic in 1993 (UNB, Dhaka, 2001).

2. SITUATION IN BANGLADESH

Groundwater arsenic level exceeding the WHO recommended value (0.05 ? g/L) have been found in 57 Zilas (districts) out of 64 in Bangladesh (NHCSR, 2000). Arsenic in shallow tube well water has been detected in almost all districts of Bangladesh. In the acute arsenic problem areas, more than 90 percent of the shallow tube wells have been found to produce contaminated water exceeding 0.05 mg/l of arsenic. (Fig 01)

*Dr. Golam Rahman, Professor, Department of Urban and Regional Planning, Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh.
And
*M. A. Matin Miah, an MURP Student, Department of Urban and Regional Planning,
Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh

Fig - 01: The map below shows the arsenic contamination of underground water in Bangladesh:



According to the National Hydro-Chemical Survey, 57 Zilas out of 64 have found arsenic in tube well water at more than permissible level (Table 1,Fig –02 & Fig 03).

Table - 01: Compliance with Bangladesh standard (50µg/L)

	NUMBER		
	<50µg/L	>50µg/L	TOTAL
DIVISIONS	0	6	6
ZILA	8	53	61
UPA ZILA	184	249	433

Source: National Hydro-Chemical Survey (2000)

Fig – 02: Arsenic Contamination of Underground Water in Bangladesh.

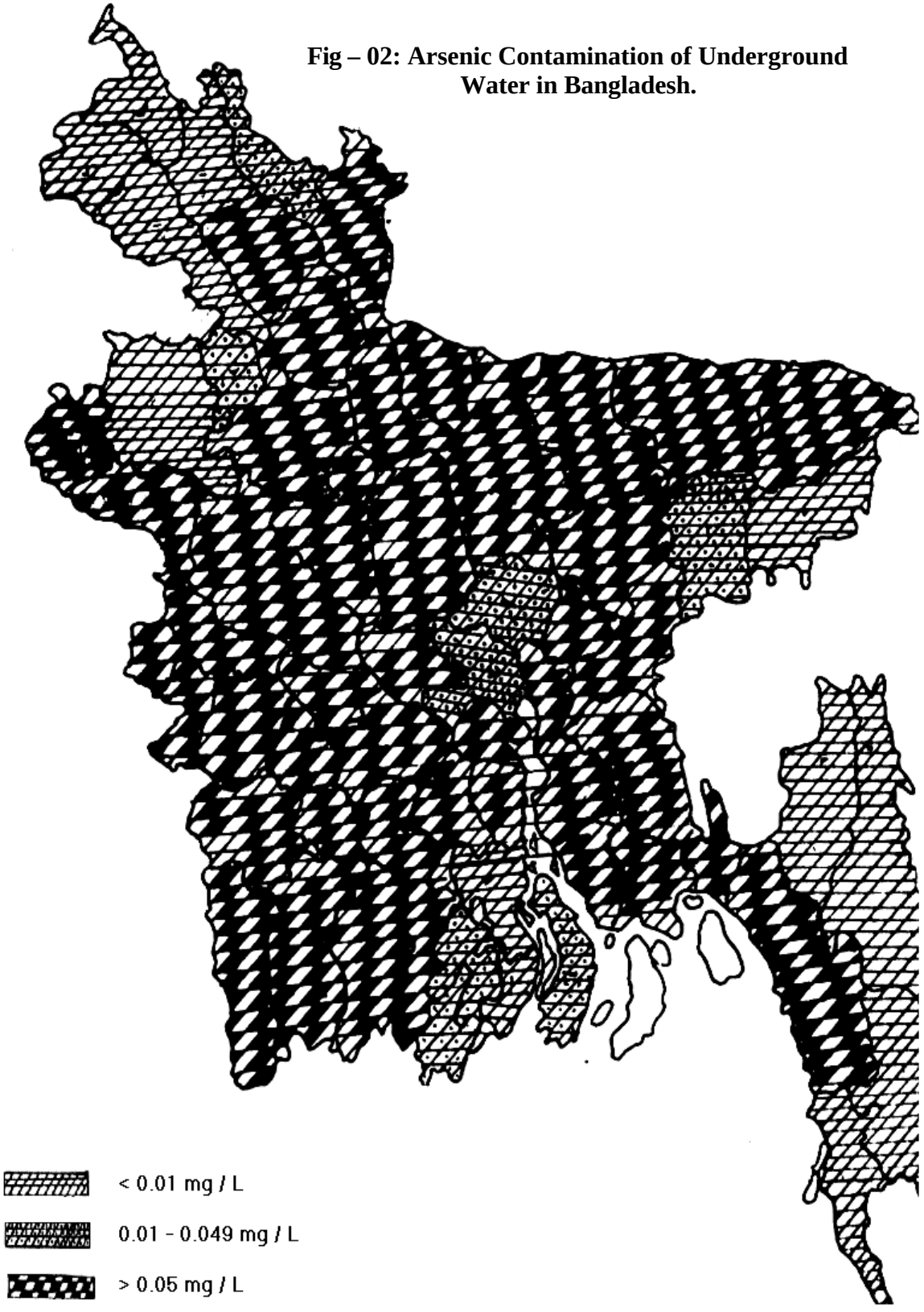
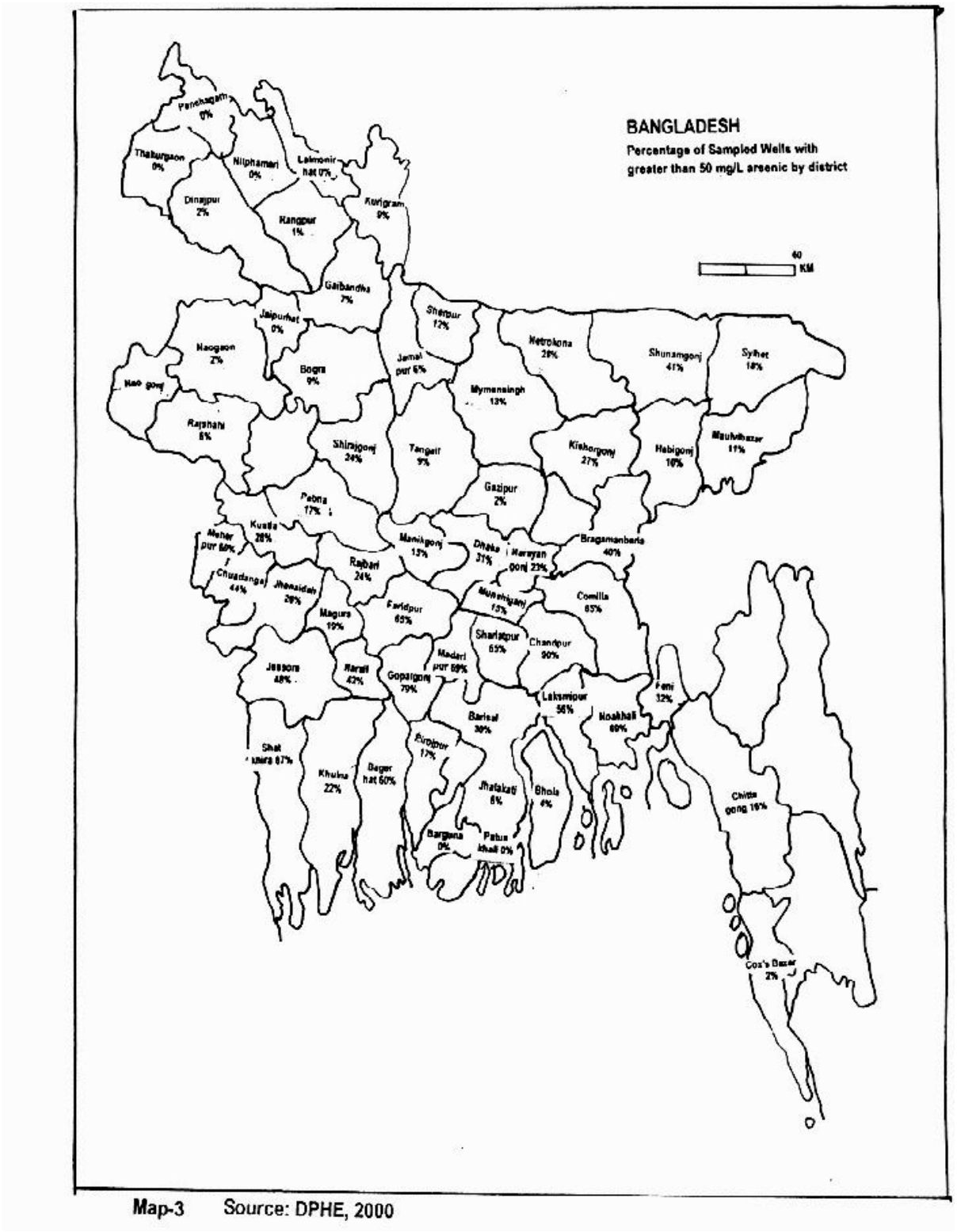


Fig - 03: The map showing percentage of sampled tube wells with greater than 50-µg/L arsenic by Zilas.

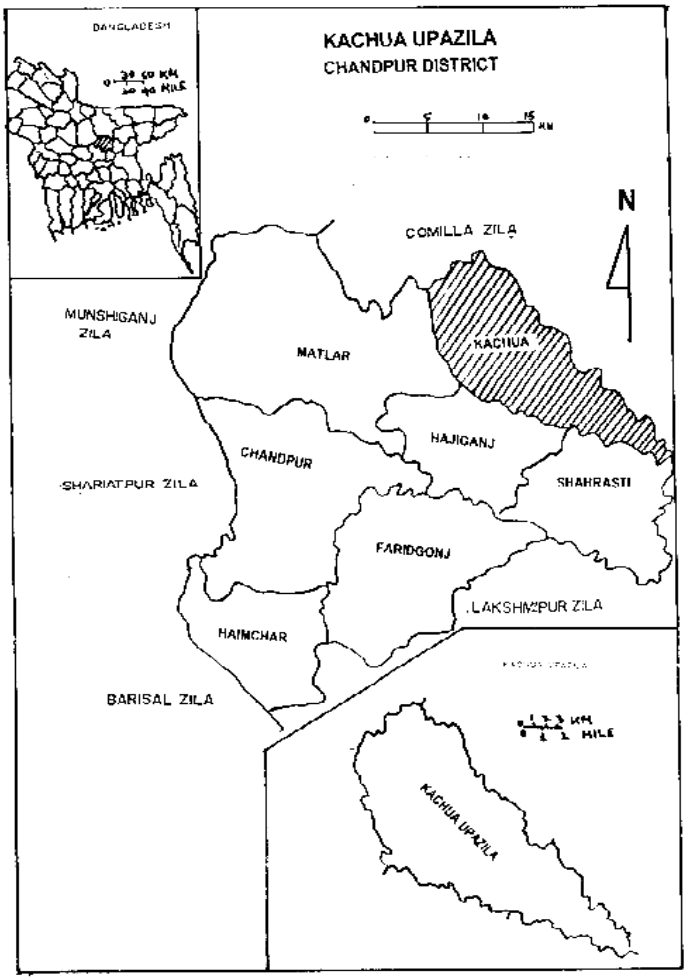


Map-3 Source: DPHE, 2000

3. CASE STUDY: KACHUA UPAZILA OF CHANDPUR DISTRICT.

Kachua Upazila is situated roughly within $23^0$14'35" North latitude to $23^0$28'30" North latitude and $90^0$47'45" East longitude to $91^0$1'45" East longitude under the district of Chandpur. It is located about 25 miles North-East corner of Chandpur town and 80 miles South-East corner of Dhaka city on way to Comilla is connected by a paved road (Fig – 4).

Figure – 04:Study Area.



Map-4

The population of Kachua Upazila is 2,93,683 and out of this the male and female population are 145956 and 147727 respectively. The total area of Kachua Upazila is 235.61 sq. km. and the population density is 1246 per square km. On the other hand the total household in the study area is 50262 and the density of the household is 213 per sq. km.
The total number of working tube-wells in Kachua Upazila is 17787 (Action Research 2000). There are 245 villages within 12 Unions in Kachua Upazila. So each Union has 1482.25 tube-wells and each village has 72.6 tube-wells on an average. Union-wise number of population, households, and tube-wells in the Kachua Upazila of Chandpur district are given below.

Table –2: Union-wise number of population, households and tube-wells in the Kachua Upazila of Chandput district.

Unions	Total area in sq. km.	House-hold	Population	Total number of tube-wells	No. of house-holds depend on a single TW.	Population density (per sq. km.)	No. of TW / sq. km.	No. of people depend on a single TW.
Ashrafpur	23.36	49.42	27775	2381	2.08	1189	102	12
Bitara	29.61	5250	32646	1594	3.29	1103	54	20
Uttar Gohata	14.60	3628	21305	1835	1.98	1459	126	12
Dakshin Gohata	14.48	3828	21134	1727	2.22	1460	119	12
Uttar Kachua	16.59	3616	20927	911	3.97	1261	55	23
Dakshin Kachua	13.54	3458	21024	1344	2.57	1553	99	16
Kadla	26.97	5218	31487	1916	2.72	1167	71	16
Karaia	29.25	6463	38635	2437	2.65	1321	83	16
Purba Pathair	16.91	3613	20119	878	4.11	1190	52	23
Paschim Pathair	14.81	3140	18738	754	4.14	1265	51	25
Purba Sahadevpur	16.92	3407	18593	897	3.8	1099	53	21
Paschim Sahadevpur	18.57	3699	21300	1113	3.32	1147	60	19
Total	235.61	50262	293683	17787	2.8	1246	75	17

Source: DPHE & Grameen Bank, 2000

4. NATURES AND EXTENT OF THE ARSENIC CONTAMINATION PROBLEM IN KACHUA UPAZILA OF CHANDPUR DISTRICT

The important attempt of the survey through questionnaire was to know how many households are depended on a single tube-well in the study area. It is found that 1-2 households, depend on a single tube-well for water, are the major number of households (about 26.5 percent); 3-4 households, depend on a single tube-well, are the second highest category of the families (about 23%) and 1-4 families, dependent on a tube-well, are about half of the total households (about 49.5%). There are large numbers of households (about 19.5%) who are dependent on a single tube well in the study area (Table-3). Therefore, it can be said that there is very little homogeneity in the distribution of tube-wells in the study area.

Fig 05

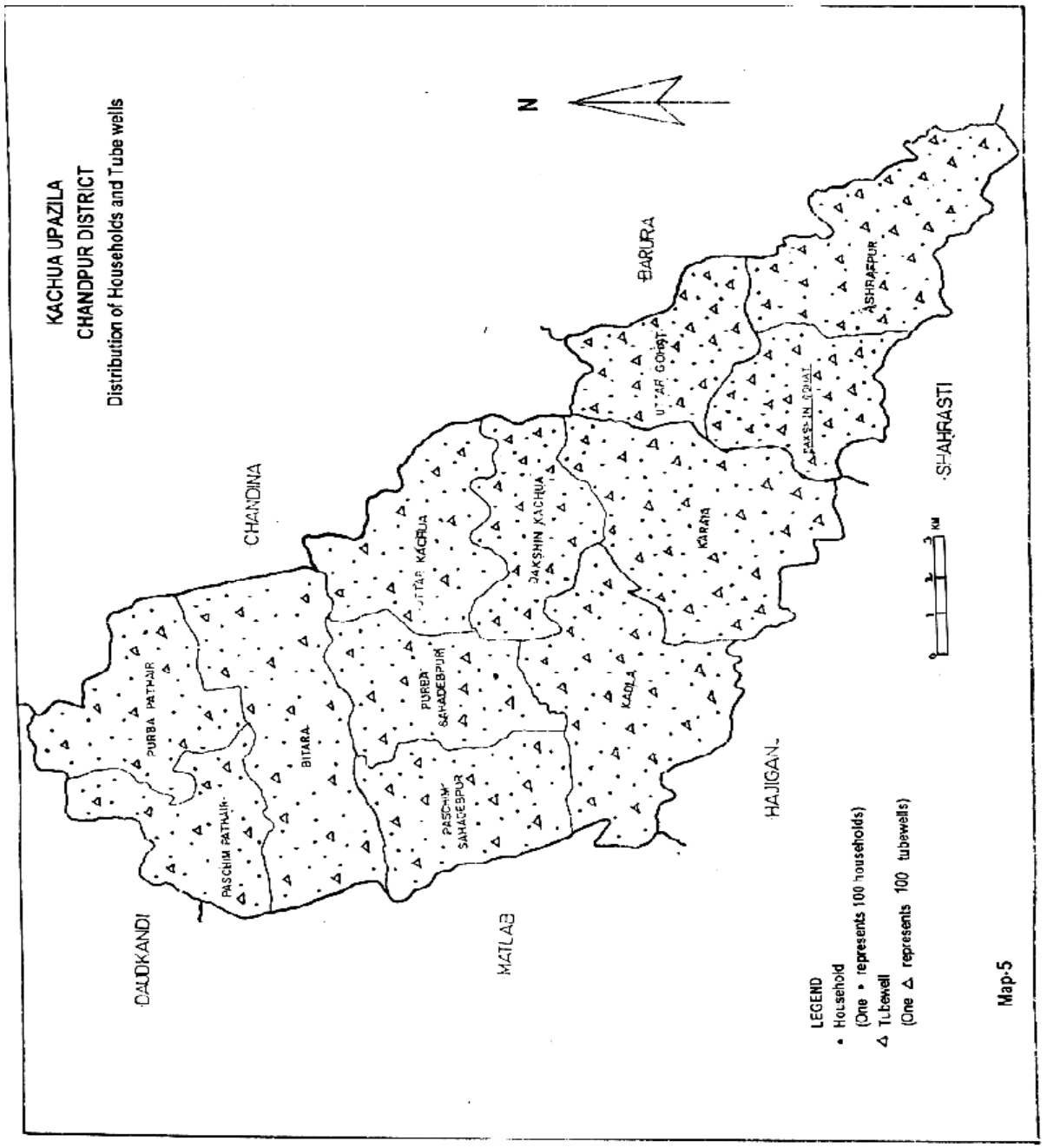


Table 03: Information about the number of respondents dependent on a single tube-well.

No. of households	Frequency (no. of HH)	Percentage of Respondents
1-2	53	26.5
3-4	46	23
5-6	35	17.5
7-8	14	7
9-10	13	6.5
11 and above	39	19.5
Total	200	100

Source: Field Survey, 2000.

It is known from the survey that about 90% households of the study area are dependent on tube-well water for drinking or other purposes. 10% households avail water from different sources in spite of tube wells located far or nearer to their households (Table-4).

Table - 4: Information about availability of tube-well water for drinking or other purposes.

Availability of tube-well water	Respondents	Percentage of Respondents
Avail	180	90
Do not avail	20	10
Total	200	100

Source: Field Survey, 2000.

Through the survey, it is found that almost all tube-wells (98.5%) in the study area are arsenic affected (Table-5). But it is also found that most of these contaminated tube-wells (91%) are being used frequently for different purposes. (Table-6).

Table – 5: Information about the present conditions of tube-well water.

Present condition of tube-well water	Respondents	Percentage of respondents
Arsenic affected	197	98.5
Not arsenic affected	3	1.5
Total	200	100

Source : Field Survey, 2000.

Table – 6: Information about the condition of the arsenic affected tube-well.

Condition of the arsenic affected tube-well	Respondents	Percentage of respondents
Running	182	91
Not running	18	9
Total	200	100

Source: Field Survey, 2000.

Although 98.5% tube-wells in the study area are arsenic affected and most of these tube-wells (91%) are being used frequently as sources of drinking and cooking water but a very few number of people (6.5% respondents) viewed that they are arsenic affected. (Table-9). They are suffering from fracture spot in hand (61.5%), visiple (foshka) in hand (23.1%), infection in leg (15.4%) etc. associated with arsenic affect mostly suffer from poverty and malnutrition. The above symptoms are identified within a year (53.7%) and in some cases 42 percent in above one year (46.2). So it can be said that health hazards of arsenic in human body in the study area are diagnosed in recent times (Photograph 01-06; source: field survey 2000).

Table – 7: Information about arsenic affected condition in the family member of the Respondent.

Condition of the family member	Respondents	Percentage of respondents
Arsenic affected	13	6.50
Not arsenic affected	187	93.50
Tot l	200	100

Source: Field Survey, 2000.

Although various studies and information reveal that a severe arsenic disaster in drinking water in the study area prevails but no substantial action has yet been put into operation for its immediate remedy. Through the survey it is found that most of the people in the study area (about 86% respondents) do not have any water-filtering instrument. Only 14% respondents have it (Table-8).

Table – 08: Information about the condition of water filtering instrument.

Condition of water filtering instrument	Respondents	Percentage of respondents	Filtering instrument provided by					
			GO		NGO		Self	
			Freq.	%	Freq.	%	Freq.	%
Have	28	14	03	10.71	23	82.14	02	7.14
Have not	172	86						
Total	200	100						

Source: Field Survey, 2000.

It is found through the survey that the major existing drinking water sources are tube wells and ponds. It is revealed that tube well water is mainly used for drinking and cooking purposes. Among 87.21 percent of the total respondents, about 44.03 percent use water for drinking purposes and 43.18 percent for cooking purposes. About 90% people in the study area usually avail themselves of tube well water. On the other hand, 53% people in the study area stated that harvested rainwater is drinkable (Table-9).

Table - 09: Information about the drinking condition of water of the existing sources.

Existing water sources	Drinking condition			
	Drinkable		Not drinkable	
	Freq.	%	Freq.	%
Tube well	19	9.5	181	90.5
Deep tube well	41	84	8	16
Pond	26	3	174	87
Rain water Harvesting	19	53	17	47
Canal	2	5	40	95
River	-	-	5	100
PSF	10	100	-	-
Other	1	50	1	5

Source: Field Survey, 2000.

From the survey it is found that most of the tube wells (71.5% of the total tube wells within the survey area) are located within 10 meters from the houses of the respondents. Moreover about 82.5% tube wells are located within 15 meter from the house of the dwellers in the study area. On the other hand maximum ponds (69%) in the study area are located within 15 meters from the houses of the respondents.

Table - 10: Information about the relative distance of the existing source of drinking water from the houses of the respondents.

Water Source	Distance of the existing sources of drinking water from the house of the respondents .													
	(o-2)m		(3-5)m		(6-8)m		(9-11)m		(2-14)m		15 m-1 km	2	2 km+	1
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Tube well	21	10.5	61	30.5	24	12	37	18.5	19	9.5	32	16	6	3
Deep Tube well	1	.5	2	1	3	1.5	4	2	1	.5	73	36.5	116	58
Pond	13	6.5	34	17	30	15	35	17.5	26	13	59	29.5	3	1.5
Harvested Rainwater	2	5	2	5	-	-	-	-	-	-	1	2.5	31	86
Canal	1	-	1	-	4	-	2	-	1	-	23	-	22	-
River	1	-	-	-	2	-	1	-	-	-	4	-	3	-

Source: Field Survey, 2000.

5. SAFE WATER OPTIONS IN KACHUA UPAZILA OF CHANDPUR DISTRICT:

Some of the principal water options are discussed below:

5.1 Pond Sand Filter (PSF)

PSF technology provided by the DPHE and Gramen Bank is also considered appropriate for areas where ground water is contaminated with arsenic. One pond sand filter can supply pure water for about 200 families (Report of Action Research, 2000). In Kachua 10 PSFs are installed beside 10 ponds (Table-11).

Table – 11: Village-wise PSF list.

Sl. No.	Union	Number of PSF
01	Dakshin. Kachua	1
02	Dakshin Kachua	1
03	Koroya	1
04	Sachar	1
05	Dakshin Gohat	1
06	Asrafpur	1
07	Kadla	1
08	Bitara	1
09	Bitara	1
10	Shadebpur	1

Source: Report of Action Research on Community Based Arsenic Mitigation Project, Grameen Bank, 2000.

5.2 Different home-based arsenic removal sand filters

Grameen Bank has installed three different types of home-based sand filter like Pitcher Filter (Photograph 01 - 04), Chari Filter and Two-bucket filters (Table-12 and photograph 1 - 4). All these filters work on Pond Sand Filtering system. This technology is very effective in removing arsenic.

5.3 Rain Water Harvesting (RWH)

Rainwater is safe for drinking if it is collected sufficiently. To mitigate the demand of water, Grameen Bank has constructed 162 Rain Water Harvesters in the study area for community use (Table-12). From May 2000 all of the 162 RWHs are working. The drawback of the technology is that rainwater is available only for a few months of the year.

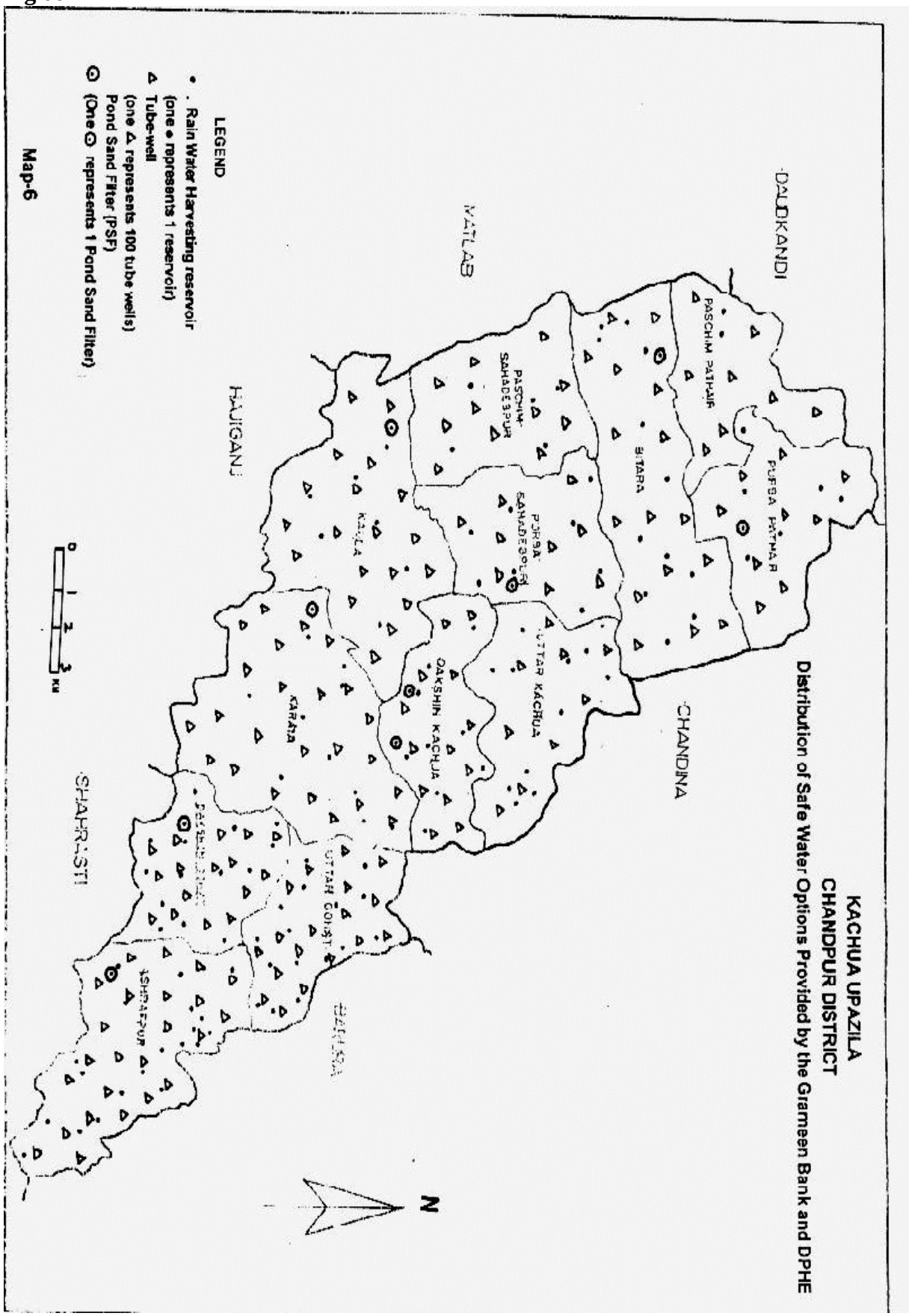
Table – 12: Number of water options constructed / supplied in Kachua Upazila

Options	Kochua	
	Proposed	Constructed / Distributed
Pond Sand Filter (PSF)	9	10
Rain Water Harvester (RWH)	210	162
Pitcher filter	None	1500
Chari filter	None	6
Two-bucket filter	None	6

Source: Report of Action Research, 2000.

The distribution of tube-wells, Pond Sand Filters (PSF) and Rain Water Harvesting Reservoirs are shown on the Fig 06.

Fig 06


KACHUA UPAZILA
CHANDPUR DISTRICT
Distribution of Safe Water Options Provided by the Grameen Bank and DPHE
Map-6
LEGEND
. Rain Water Harvesting reservoir (one • represents 1 reservoir)
Tube-well (one Δ represents 100 tube wells)
Pond Sand Filter (PSF)
(One ⊙ represents 1 Pond Sand Filter)
DAUDKANDI
MATLAB
HAJIGANJ
CHANDINA
SHAHRASTI
PASCHIM PATHAIR
PASCHIM SAHADEBPUR
PURBA PATHAIR
SITARA
PURBA SAHADEBPUR
KALA
KARAIA
DAKSHIN KACHUA
UTTAR KACHUA
UTTAR GOHAT
ISHABPUR
N
0 1 2 3 KM

6.STRATEGIES PROPOSED BY THE RESEARCHER AND OTHER ORGANIZATIONS FOR THE MANAGEMENT OF GROUNDWATER POLLUTION

Three approaches to combat arsenic problem is suggested and they are:

6.1 Short-Term Approach

I. Awareness among the people in the arsenic affected areas about the ill effects of arsenic.
II. Sealing off the contaminated tube wells.
III. Supply of arsenic free drinking water almost on a day-to-day basis from another source, like arsenic free tube well.
IV. Medical treatment of the arsenic affected people.

6.2 Medium- Term Approach

I. Educate people who are at risk of arsenic contamination about ill effects of arsenic and how to avoid the same.
II Supply arsenic free water from a protected water supply scheme for both drinking and also for household purposes.
II. Appointment of lady doctors in rural health centers and clinics for check-up and treatment of women patients
III. Arrange training of local villagers with regard to use of arsenic kits.

6.3. Long-Term Approach

6.4.

I. Formulate a national strategy to resolve arsenic problem.
II. Identify arsenic free sources by integration of various technologies.

III. Periodic health cheek-up of all those who live in the vicinity of arsenic contaminated areas.
IV. Rehabilitation of arsenic affected persons.
V. Establishing Primary Health Centers (PHCs) in all unions.

7. RECOMMENDATIONS

The following steps may be recommended to encounter the arsenic hazard:

1. Build Awareness Through Mass Communication.

2: Providing Safe Drinking Water.

In selecting the source of supply of safe drinking water, the following order of preference may be followed: -

Only tube wells with safe drinking water may be used. Water option for deep tube well should be installed in each clustered household within the village. The water connection to rich individual household at affordable price may be provided and some extra storage provision to the areas of poor households should be supplied. This may pave the augmentation of clustered village settlement with arsenic free water.

?? Surface water can be used with appropriate and adequate treatment.
?? Rainwater can be harvested and stored.

3: Providing Medical Care at Health Centers For Seriously Affected Patients.

8. CONCLUSIONS

Arsenic problem in Kachua is a part of the problem in context of Bangladesh. It is a great natural and national calamity. A number of institutions, universities, government and non-government organizations and donor agencies including World Bank are working on various aspects of arsenic contamination in drinking water. Several projects have been undertaken to understand the magnitude of the problem even in Kachua and to adopt mitigation measures but it appears to be the beginning of addressing the problem nationwide. Considering the water resources available on the surface and in the sub-surface, it is recommended that people in the affected areas have to choose one of the four options offered to get arsenic free water. The options are sinking of deep tube wells (in the clustered-village), the excavation of wells, digging new wells and installation of locally developed technology such as Pitcher Filter, Bucket Filter and Pond Sand Filter (PSF) on banks of ponds.

Kachua being a remote rural sub-district requires the assistance of the government, the donor agencies and the NGOs to mitigate the gigantic arsenic contamination problem. The local people are willing to work closely with the government and the NGOs. So by strengthening the local governance and the people's participation in the village community and with the assistance of the central government, this problem may be resolved. This will ensure a vista of sustainable living environment in rural areas.

REFERENCES

Ahmed, Ahsan Uddin 1998. *Contamination of Ground Water with Arsenic*: A Great Environmental Disaster in Bangladesh, Asia-Pacific Journal on Environmental and Development, Vol-5, No-2.

Ahmed, M. Feroze. 2000. *Strategic Plan for Arsenic Mitigation in Bangladesh, Bangladesh: Environment 2000*, Bangladesh Poribash Andolon, Dhaka.

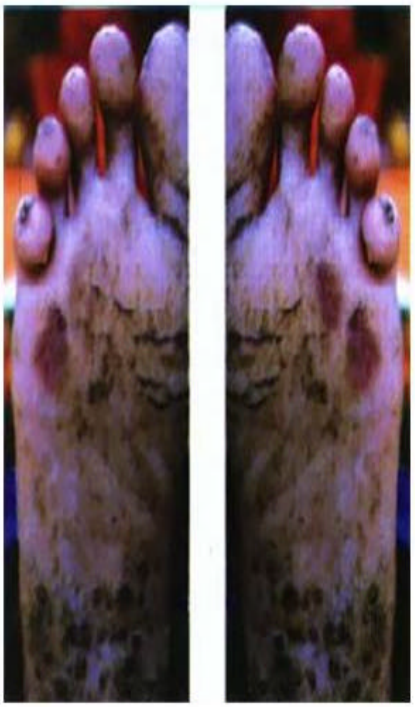
Ashrafi, Azmeri. 1999. *Arsenic Contamination in Ground Water*, A Thesis for Graduation Degree from Khulna University.

DCH, 1997: Arsenic Pollution in Bangladesh, Monthly Newspaper of Dhaka Community Hospital, Vol.-8, Iss.-2.

DPHE and UNICEF 1988-93. Water Supply and Sanitation Project Implementation Guideline and Specification for the Rural Areas of the Coastal Region, An Interim Report, Dhaka.

Photograph 01: Melanosis.

Photograph 02(a): Keratosis.



Photograph 02 (b): Keratosis.

Photograph 02 (c): Keratosis.

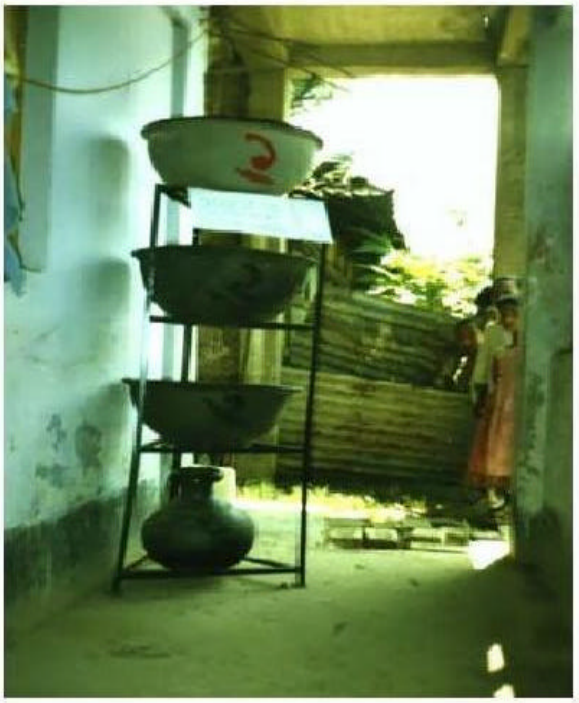
Photograph 03: Ulcer.

Photograph 04 : Gangrene.

Photograph 05: Non - pitting oedema.

Photograph 06: Conjunctivitis.

Photograph 07 (a): Bucket Filter.



Photograph 07 (b): Bucket Filter.

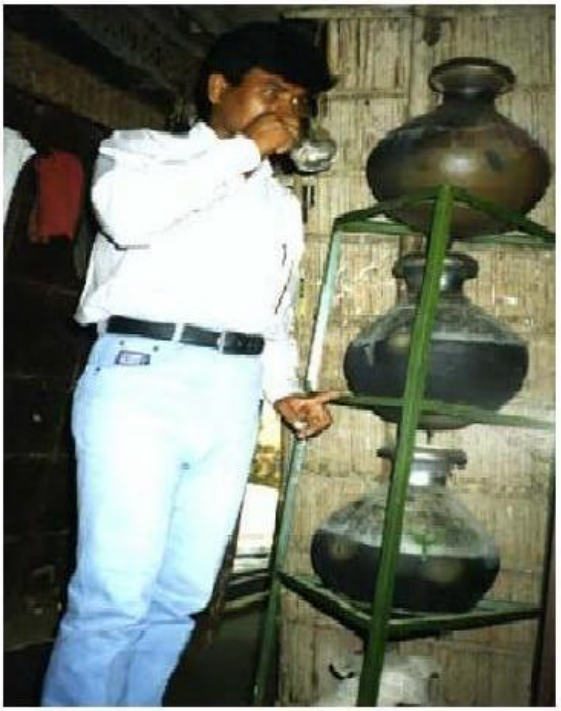
Photograph 08 (a): Pond Sand Filter.

Photograph 08 (b): Pond Sand Filter.

Photograph 02 (c): Rain Water Harvester.

Photograph 03 (b): Arsenic Free Tube Well (Green Marked).

Photograph 03 (a): Arsenoc Contaminated Tubewell (Red Marked).



Photograph 04: Pitcher Filter.