IMPACT OF ARSENIC POLLUTION ON HUMAN HELATH OF BELDANGA MUNICIPALITY, MURSHIDABAD DISTRICT, WEST BENGAL, INDIA

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***ABSTRACT*: Arsenic pollution in groundwater is a serious threat to mankind. Arsenic as a mineral is present in different forms in nature with varying toxicity. Arsenite and arsenate are the most common toxic forms of inorganic arsenic mainly found in groundwater. Arsenic in groundwater and its effect on human health and is concern at the global level. West Bengal is one of adversely affected states of India, where arsenic level is above the permissible limits (> 0.05 mg/litre). Arsenic contamination in groundwater in the Gangetic plains of West Bengal, because of its telling effects on human health, has been reported as one of the biggest threats to the inhabitants. My study area, Beldanga municipality, a small town under the Berhampore sub-division (sadar) in Murshidabad district,West Bengal. *Beldanga Municipality* was designed as a Municipality in 1981. This Municipality currently consist 14 wards. geographically extends longitudinally from 88°14´05´´Eto 88°15´49´´E and latitudinally between 23°55´40´´N and 23°56´47´´N covering an area of 3.98 sq. Km. I have chosen six wards in Beldanga municipality for primary survey. In this study I shall show the impact of arsenic pollution on human life, the resulting chronic diseases affecting human body and to study the mitigation techniques and suggestions.**

***Keywords*: Arsenic Pollution, Arsenicosis, Literacy and Arsenicosis, Mitigation Techniques.**

INTRODUCTION

Groundwater is one of the important elements of environment which is essential for life. It is used for various purposes like - domestic, agricultural, industrial etc. Subsurface water is considered safe and is being used as a major source of drinking water in most of the part of India, particularly in rural India. Considering, to safety of groundwater in terms of being free from contamination and recommendation of world health organisation, tube wells were dug even in areas like west Bengal where fresh water is available. Hence people and government both opt to use tube well water for drinking and other purposes. Underground water where on one hand is safe but at the same time it is capable of dissolving a variety minerals and metals, like arsenic etc. In recent ages, arsenic pollution in groundwater is a serious threat to mankind. Arsenic as a mineral is present in different forms in nature with varying toxicity. Arsenite and arsenate are the most common toxic forms of inorganic arsenic mainly found in groundwater.

Arsenic is one of such element which is found in the earth crust and is a cause of concern throughout the world (**Bhattacharya et al. 1997, Mukherjee et al. 2006**). Human health is adversely affected even if it is consumed in trace amount for a longer duration. The permissible limit recommended by WHO is **0.01 mg/litre** in developed countries and **0.05mg/litre** for India and Bangladesh (**WHO, 1993, Ravenscroft et al. 2009, Karim et al. 2000**).

The impact of arsenic contaminated drinking water was first detected in 1980's in West Bengal when the first case of skin ailment appeared. During 1980's arsenic pollution was reported in the district of N 24 parganas, S 24 Parganas, Nadia, Murshidabad and Barddhaman in West Bengal and now it has become a devastating calamity in numerous parts of the state.

OBJECTIVES OF THE STUDY

The main objectives of this study are as follows:

1. To study the impact of arsenic pollution on humans in selected six wards of *Beldanga Municipality.*
2. To assess the mitigation techniques and suggestions.

DATABASE

The study has been based on both Secondary and Primary information. Secondary data have been collected from different government departments and primary data have been collected through *household survey.*

a. **Source of Secondary data**

Secondary data are those data which are collected from secondary sources like-

a. Census of India, 2011.

b. Beldanga Municipality.
c. Public Health Engineering Department, Government of India, West Bengal.
d. Central Ground Water Board (CGWB) and Sate agency.

b. **Source of Primary data**

Primary data have been collected from selected Six wards (Ward No.-9,10,11,12,13,14) through household survey running a structured questionnaire (provide in Appendices) by applying random sampling in Beldanga Municipality.

LITERATURE REVIEW

The problem of arsenic has been addressed by different scholars in different ways-

Sengupta (2003) discussed the concentration of arsenic in the Ganga-Padma-Meghna-Bramhaputra plain of India and Bangladesh.

Ghosh and Ghosh (2014) mainly focused on the level of arsenic contamination in groundwater, impact of such arsenic pollution on human health, mitigation techniques and suggestion to local people and the government of Ketugram-II block in Bardhaman district.

"West Bengal is one of adversely affected state of India, where arsenic level is above the permissible limits (> 0.05 mg/litre). The findings of this paper are based on Nadia District which is one of the adversely affected parts of the state. The concentration of arsenic is very alarming in northern and southern part of the district. The prevalence rate of arsenicosis is coterminous with it...."- **Kanchan and Ghosh (2011).**

Roychowdhury (2010) extensively worked on arsenic contamination in 107 blocks of West Bengal.

"This is a study on medical geographical problems concerning the consequences of the consumption of water being polluted by arsenic poison covering the wide areas nine districts- Malda, Muurshidabad, Nadia, N-24-parganas, S-24-Parganas, Hooghly, Howrah and Kolkata parts, South Bengal (West Bengal)."- **Bhattacharjee (2011).**

Ghosh (2014) mainly discussed the identification and spatial analysis of groundwater vulnerability zones of Murshidabad district and also focused on impact of arsenic pollution on human health in different blocks of Murshidabad district.

Samanta et al. (2004) attempted a study in West Bengal in respect to arsenic contamination and it's effect on hair, nail, and skin-scales.

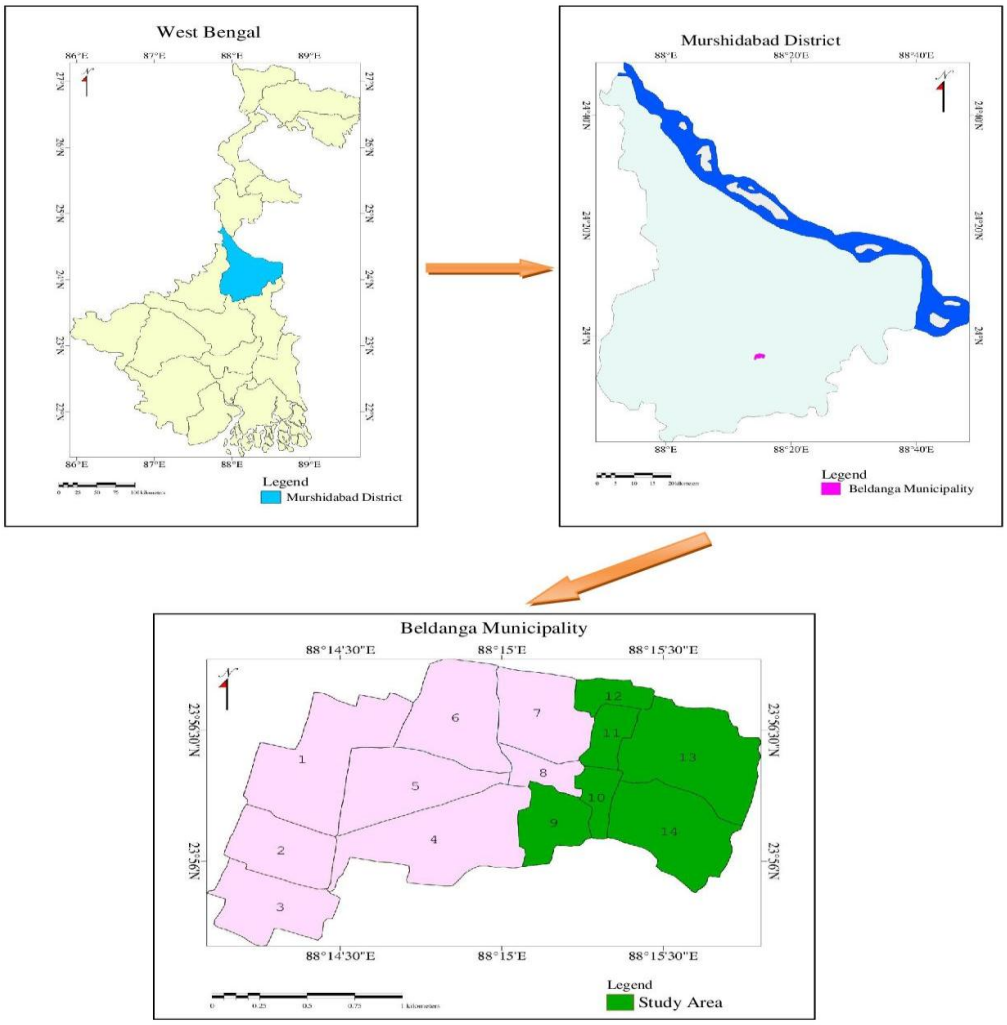
Recent updates on arsenic contamination and human health issues around the world was reviewed by **Naujokes et al. (2013)** while **Vahter et al. (2008)** worked on the effects of early life exposure to arsenic contamination.

Whitacre (2008) discussed the arsenic pollution and remediation with special reference to Bangladesh.

Chakraborti (2003) mainly focused on the arsenic contamination in the middle Ganga plain of Bihar and considered it as **'Future Danger'.**

LOCATION AND GEOGRAPHICAL EXTENT

Beldanga Municipality, geographically extends **longitudinally** from **88°14´05´´Eto 88°15´49´´E** and **latitudinally** between **23°55´40´´N and 23°56´47´´N** covering an area of 3.98 sq. Km. Beldanga Municipality is situated under the Berhampore sub-division (sadar) in Murshidabad district.



(Fig. No.1).

PHYSICAL SETUP

***a*)Physiography:** The entire Murshidabad district is plain with elevation varying between 10-50 metre above the mean sea level (**District Resource Map, 2008**). The average elevation of Beldanga is 20 metre above mean sea level.

***b*)Geological setting:** The whole district is associated with the unconsolidated sediments of the late **Pleistocene** to **late Holocene** time. The Bhagirathi formations, also contain silt and clay and are associated with present day fine grained flood plain regions. A small patch of **Rajmahal trap**, associated with **basaltic rock** is situated in the north-western part of the district.

***c*)Drainage:** The major river of the district is **Ganga** and it's distributaries like **Bhagirathi, Bhairab and Jalangi**. The river flows from north-west to south-east along the northern flank of the district. River **Bhagirathi** is flowing along the western side of *beldanga Municipality.*

d)Soil: The eastern segment of the district which is on the east of the river '*Bhagirathi*' is associated with fertile light alluvial soil locally known as '**Bagri**' (fine loamy and sandy). *Beldanga Municipality* is situated under the '**Bagri**' portion. The western part of river 'Bhagirathi' is known as '**Rarh**'.

e)Climate: The climate of the district is *hot and humid*. Rainfall mainly occurs from the *south west monsoon*. Average rainfall of the district is about **1400-1700 mm** and 74% of it falls between *June and September*. Mean monthly temperature varies between 17°c to 35°c. May is the hottest month with *46°c* highest recorded temperature. *December and January* are the winter months, January is the coldest month with minimum temperature between 9°c and 11°c and maximum of 25°c.

f)Vegetation: *Deltaic environment type of vegetation* is dominant and *bamboo* is found everywhere in the district. *Bot, Aswatha, Sal, Segun, Mahua, Mango, Jackfruit* etc are usually found.

ARSENIC IN DRINKING WATER

Arsenic may be found in underground water and if the level of contamination is > 0.05 mg/litre then it is injurious to human health (**WHO, 2001**). Severe health effects have been observed in populations drinking arsenic rich water over long period. This element is widely distributed throughout the earth's crust. It is introduced into groundwater in some areas of West Bengal and Bangladesh through the dissolution of minerals and ores and erosion of local rocks (**Ravenscroft et al. 2009**). Industrial influents also contribute arsenic to water. Inorganic arsenic occurs in low and moderate aquifers of West Bengal and thus in drinking water (**WHO, 2001**).

SOURCE OF ARSENIC IN BENGAL DELTA

In terms of arsenic concentration and areal coverage, Bengal basin is one of the major arsenic affected regions in the world (**Henke, 2009**). There are many views about sources of arsenic in Bengal delta and four major mechanisms have been put forwarded:

a)Oxidation of pyrite

Mandal et al (1998), Mallick and Rajagopal (1996) have postulated that the concentration of arsenic in alluvial sediments of Bengal basin is mainly due to oxidation of pyrite present in the subsurface lithology, associated with withdrawal of groundwater, depletion of water table and finally aeration of previously anoxic sediments.

b)Comparative Ion excha

Hypothesis put forwarded by **Acharyya et al. (2000)** stated that, arsenic ions are absorbed into the sediments, displaced into the solution by comparative ion exchange with phosphate which is mainly used in fertilizers. In case of West Bengal the study of **Mukherjee** and **Fryar (2008),** shows that there is no trace of phosphate in the deeper aquifer.

c) Reductive Dissolution of Iron oxy-hydroxide

According to **Bhattacharya et al. (1997), Nickson et al. (1998,2000), McArthur et al.(2001),** the Bengal basin and Bangladesh, are associated with high iron and manganese indicating towards the reducing condition. Hence, under reducing condition arsenic is resultant from Ferric(Iron) oxy-hydroxide.

d)Reduction and Oxidati

The main concept of reduction and oxidation is that, at first, arsenic is mobilised through reduction of iron but local oxidation of pyrite is also possible. According to the study of **Lin et al. (2000)** crystal structure of clay, plays an important role in oxidation/reduction of arsenic. Oxidation of As (III) to As (V) takes place on the clay surface while reduction of As (V) to As (III) is not found. The study also states that oxidation depends upon the type and age of clay.

Other views about the source of arsenic in West Bengal are as follows:-

I. It is transported by the river Ganga and it's numerous tributaries from the Rajmahal trap which is situated in the western segment of the basin (**Saha et al. 1991, Acharyya et al. 2000**).

II. It is conveyed through the North Bengal tributaries of Bhagirathi and Padma rivers from the Eastern Himalayas (**Ray et al. 1999**).

III. It is mainly transported through the fluvial sediments from the Himalayas (**McArthur et al. 2004).**

ARSENIC AFFECTED AREAS IN WEST BENGAL

West Bengal is one of the most arsenic affected state among the states of India. Arsenic affected districts in West Bengal are given in the following table:

Table No.1: Arsenic affected districts of West Bengal.

Concentration of Arsenic	Name of the District
Above 0.05 mg/litre	Murshidabad, Nadia, Malda, N-24 Parganas, S-24 Parganas, Kolkata , Bardwan, Parts of Haora
0.03 mg/litre to 0.05 mg/litre	Haora, Kolkata, Parts of Hoogly, Darjeeling, Cooch bihar, Uttar Dinajpur, Dakshin Dinajpur
Below 0.03 mg/litre	Birbhum, Purulia, Purba Midnapore, Paschim Midnapore, Bankura, Bardwan

Source: Public Health Engineering Department, Government of India, West Bengal.

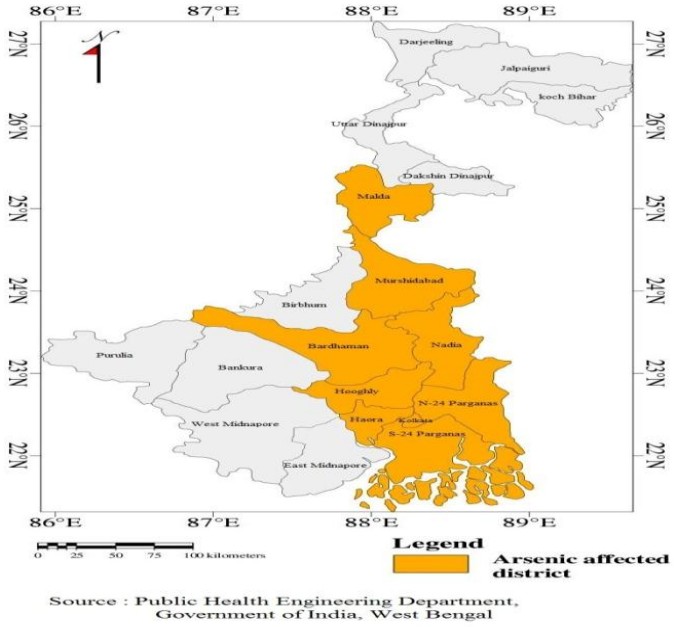


Fig. No. 2: Arsenic affected major districts of West Bengal

ARSENIC AFFECTED AREAS IN MURSHIDABAD DISTRICT

Murshidabad district is one of the most arsenic affected districts in West Bengal. In this district most of the blocks are affected from arsenic contamination in groundwater. Highly arsenic affected blocks of Murshidabad district are as follows:

Table No.2: Arsenic affected Blocks of Murshidabad district.

Concentration of Arsenic	Affected Blocks
Above 0.05 mg/litre	Lalgola, Beldanga-I, Beldanga-II, Berhampore, Bhagwangola-I, Bhagwangola-II, Domkal, Farakka, Hariharpara, Jalangi, Mur-Jiaganj, Nowda, Raghunathganj-I, Raghunathganj-II, Raninagar I, Raninagar II, Samsherganj, Suti-I, Suti-II

Source: CGWB & State agency.

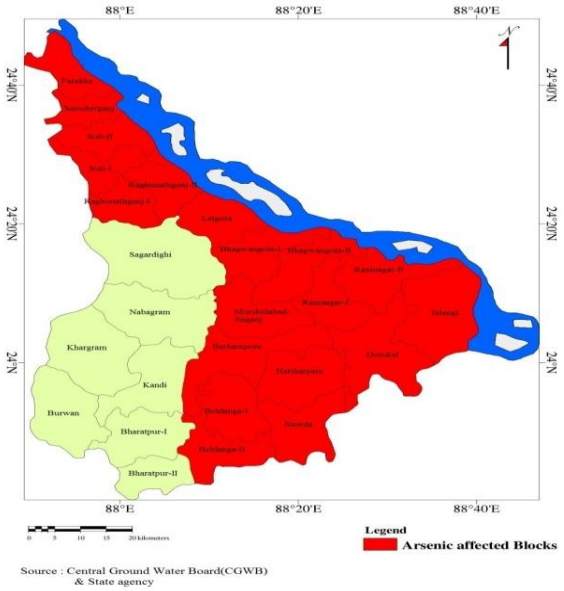


Fig. No. 3: Arsenic affected major Blocks of Murshidabad District.

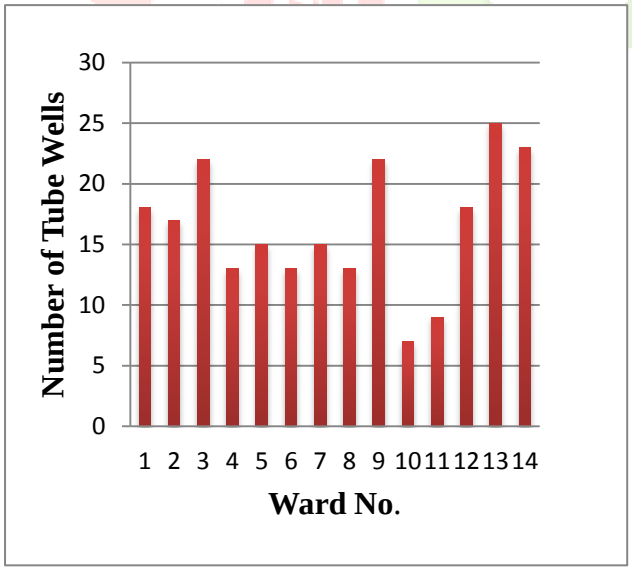
RESULTS AND DISCUSSIONS

Availability of drinking water facility: Basically, Municipality tap water is used for drinking purpose. The length of total water *pipeline* is about *15 Km.* Municipality water pipeline serve water in different wards (Fig No. 5). Beside this in this Municipality, there are numerous Tube wells. Many people used Tube well water as their drinking water, cooking and other purposes. In all of the wards there are many Tube wells. Total number of tube well in the Municipality is **230**. The highest concentration of tube well is in the **ward no. 13**, with **25 tube wells**. At 2nd position ward no. 14, with 23 tube wells. The lowest concentration of tube well is in the ward no. 10, with 7 tube wells (Table No. 3 Fig. No. 4)

Table No.3: Ward wise distribution of tube well in Beldanga Municipality.

Ward No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Number Of tube well	18	17	22	13	15	13	15	13	22	7	9	18	25	23	**230**

Source: Beldanga Municipality.



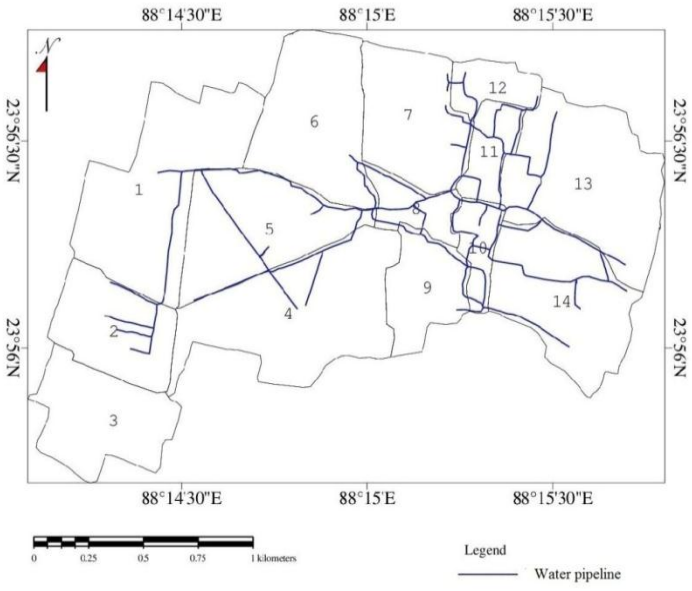


Fig. No. 4: Ward wise distribution of Tube Wells. Fig. No. 5: Municipality water pipeline map.

Availability of health facility: There are two hospitals (in ward no.2 & 7) and two private Nursing home (in ward no. 5 & 6) available in the Municipality. Except this Four health centres are available, which are situated at ward no. 1,2,12 and 14(Fig. No.6).Besides, many dispensaries are available in different parts of the Municipality. So the level of health facility in this Municipality is too good.

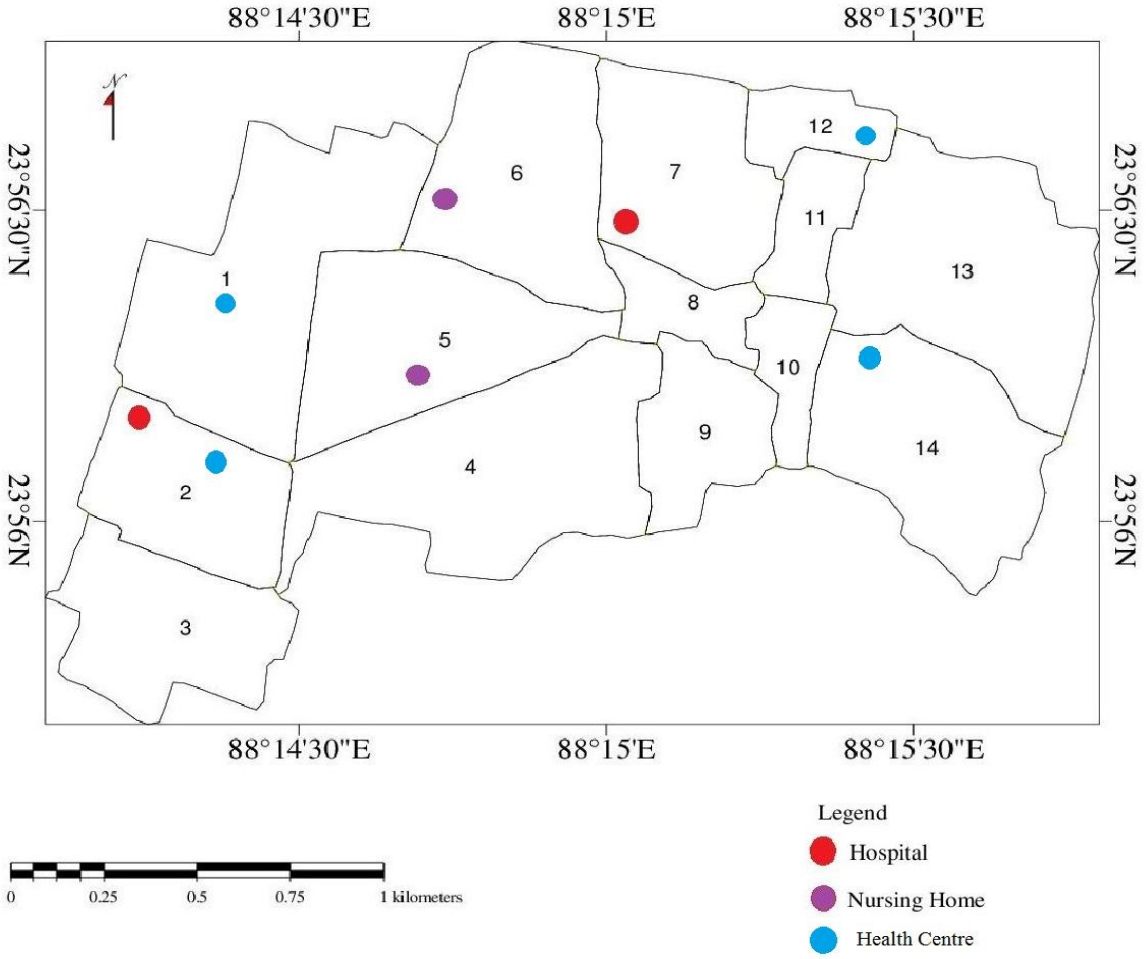


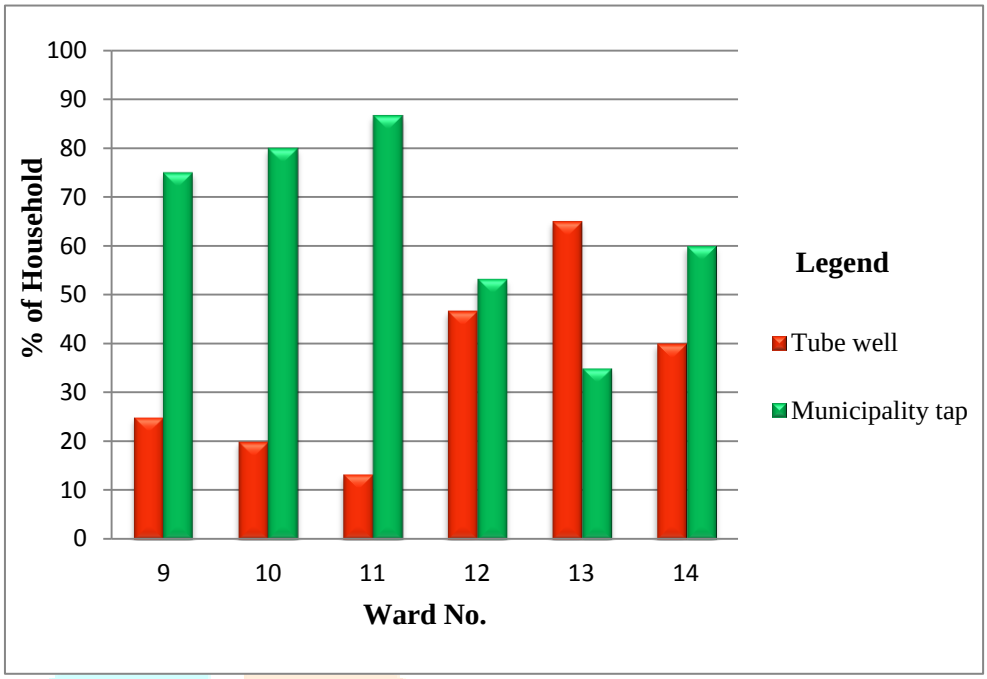
Fig. No. 6: Available health institutes in Beldanga municipality.

Main sources of Drinking water: The people of the study area in Beldanga Municipality are using Municipality Tap water and Tube well water as their main source of drinking water. 36% of surveyed total household using Tube well water in drinking and household purposes, on another hand 64% of surveyed household using Municipality Tap water as their main source of drinking water and household purposes. The using of these two sources of drinking water varying from one ward to another. In the ward no. 13 Tube well water is used very much for drinking and other purposes, with 65% households. In ward no. 9 and 10 Tube well water used in lower rate, with 25% and 20% respectively. In ward no. 11 86.66% household used Municipality Tap water for drinking and household purposes. And also in ward no. 9 and 10 Municipality Tap water is highly used for drinking, with 75% and 80% respectively (*Table No.4, fig. No.7*). In many cases, there are Municipality Tap water is available but many people didn't using the water. Especially the people of *Old generation* didn't using the safe water.

Table No. 4: Main Sources of Drinking Water in study area, Beldanga Municipality.

Ward No.	Total Household	Tube well	Tube well (%)	Municipality tap	Municipality tap (%)
9	20	5	25	15	75
10	15	3	20	12	80
11	15	2	13.33	13	86.66
12	15	7	46.66	8	53.33
13	20	13	65	7	35
14	15	6	40	9	60
Total	**100**	**36**		**64**	

Source: Field survey (2017), Sample households: 100.



Source: Field survey (2017), Sample households: 100.

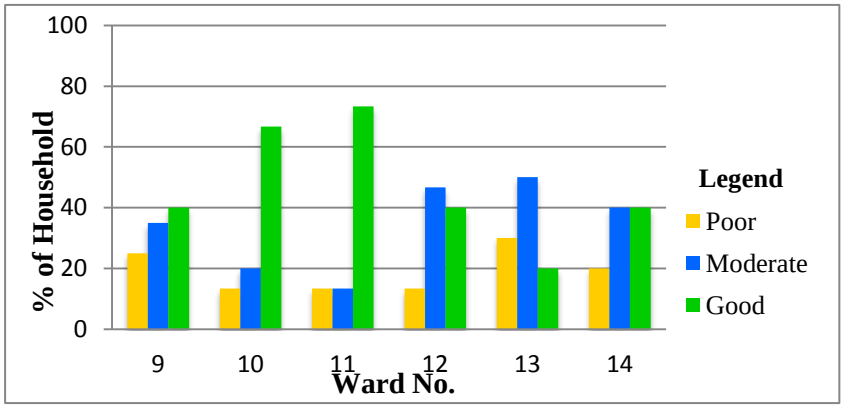
Fig. No. 7: Main Sources of Drinking Water in the study area.

Drainage Condition of Households: Drainage condition of surveyed household in the study area under Beldanga Municipality is divided into three categories- Poor, Moderate and Good. In selected six wards drainage condition have various rate. In respect to the total surveyed household 20% household is in Poor condition, 35% households is in Moderate condition and 45% households is in Good condition(Table No. 5, Fig. No.8).

Table No. 5: Drainage condition of households in the study area, Beldanga Municipality.

Ward No.	Drainage Condition						
	Total Household	Poor	Poor (%)	Moderate	Moderate (%)	Good	Good (%)
9	20	5	25	7	35	8	40
10	15	2	13.33	3	20	10	66.66
11	15	2	13.33	2	13.33	11	73.33
12	15	2	13.33	7	46.66	6	40
13	20	6	30	10	50	4	20
14	15	3	20	6	40	6	40
Total	100	20		35		45	

Source: Field survey (2017), Sample households: 100.



Source: Field survey (2017), Sample households: 100.

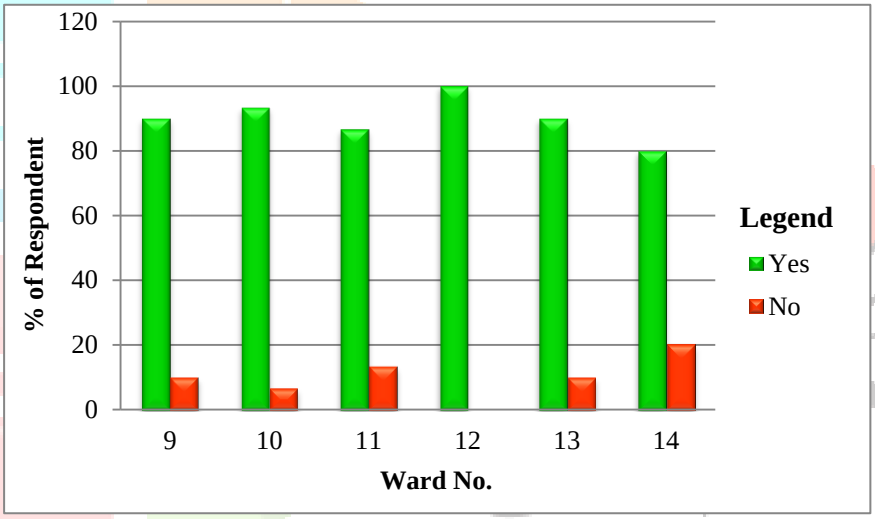
Fig. No. 8: Drainage Condition of Households in the study area.

Known people about Arsenic Pollution: At the time of household survey a question was asked them about hearing of Arsenic Pollution, many respondents answered in positive and some respondent answered in negative. 90% respondent answered in positive, where 10% respondent answered in negative (Table No.6, Fig. No.9). The response about knowing of arsenic pollution is varying in different wards. But thstatus of knowing about *Arsenic Pollution* was in enough trends. In many cases, though some people heard about arsenic pollution, but they are using Tube well water. Arsenic Pollution in *Beldanga Municipality* is in tremendous threat, many people affected from this chronic pollution. If people get aware about this threat, it will prosperous for all.

Table No. 6: Known people about Arsenic Pollution in the study area, Beldanga Municipality.

Ward No.	Total Respondent	Yes	Yes (%)	No	No (%)
9	20	18	90	2	10
10	15	14	93.33	1	6.66
11	15	13	86.66	2	13.33
12	15	15	100	0	0
13	20	18	90	2	10
14	15	12	80	3	20
Total	**100**	**90**		**10**	

Source: Field survey (2017), Sample households: 100.



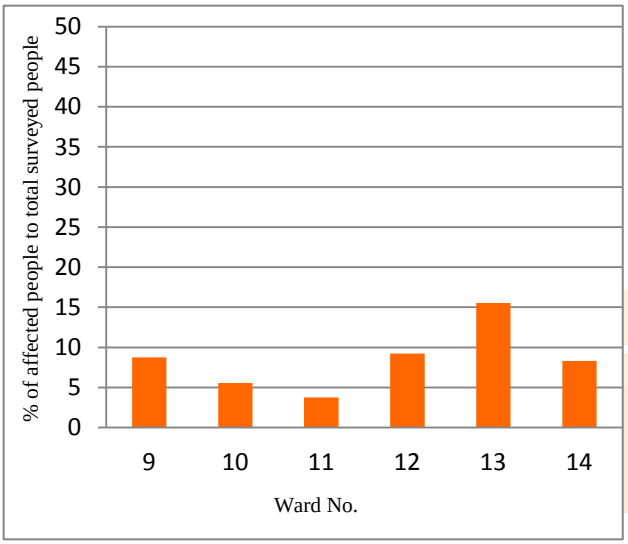
Source: Field survey (2017), Sample households: 100.

Fig. No. 9: Known people about Arsenic Pollution in the study area.

Arsenic affected People: The selected six wards of Beldanga Municipality are highly affected from Arsenic Pollution. 9.17% of total surveyed people are contaminated from Arsenic Pollution. Highly affected wards are ward no. 9, 12, 13 and 14, with 8.75%, 9.23%, 15.55% and 8.33% respectively. Rest of the surveyed wards are also affected of Arsenic Pollution, but the rate of affection is little lower. In wards no. 10 and 11 the rate of arsenic affected people are respectively 5.55% and 3.77%. The ward no. 13 consist the highest affected person, with 15.55% (Table No. 7, Fig. No. 10). In this ward in most of the households affected from arsenic pollution and most of the affected persons are aged people. Percentage of arsenic affected people to total affected persons is varying in selected six wards

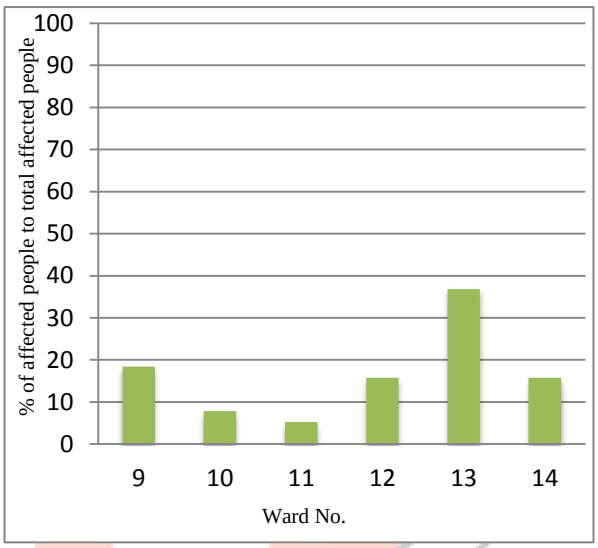
Table No. 7: Ward wise Arsenic affected people to total surveyed people.

Ward No.	Total Population	% of Arsenic affected people to total surveyed people					
		Male	Male (%)	Female	Female (%)	Total affected people	Total affected people (%)
9	80	4	5	3	3.75	7	8.75
10	54	3	5.55	0	0	3	5.55
11	53	2	3.77	0	0	2	3.77
12	65	6	9.23	0	0	6	9.23
13	90	9	10	5	5.55	14	15.55
14	72	6	8.33	0	0	6	8.33
Total	**414**	**30**		**8**		**38**	



Source: Field survey (2017), Sample households: 100.

Fig. No. 10: Ward wise % of total arsenic affected people to total surveyed people.



Source: Field survey (2017), Sample households: 100.

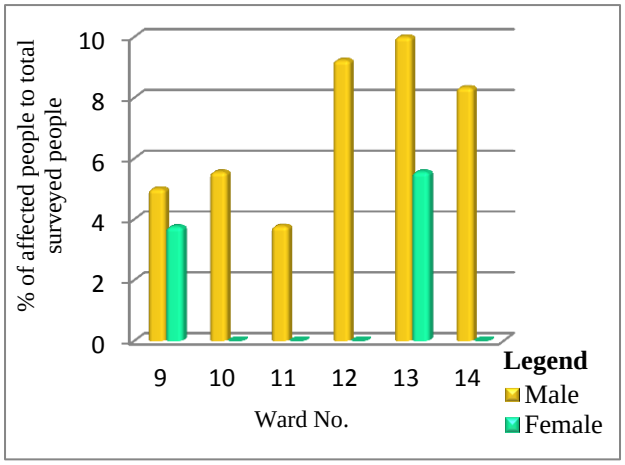
Fig. No. 11: Ward wise % of total arsenic affected people to total arsenic affected people.

Table No. 8: Ward wise arsenic affected people to total arsenic affected people.

Ward No.	Total affected people	% of arsenic affected to total arsenic affected people			
		Male	Male (%)	Female	Female (%)
9	7	4	57.14	3	42.85
10	3	3	100	0	0
11	2	2	100	0	0
12	6	6	100	0	0
13	14	9	64.28	5	35.71
14	6	6	100	0	0
Total	**38**	**30**		**8**	

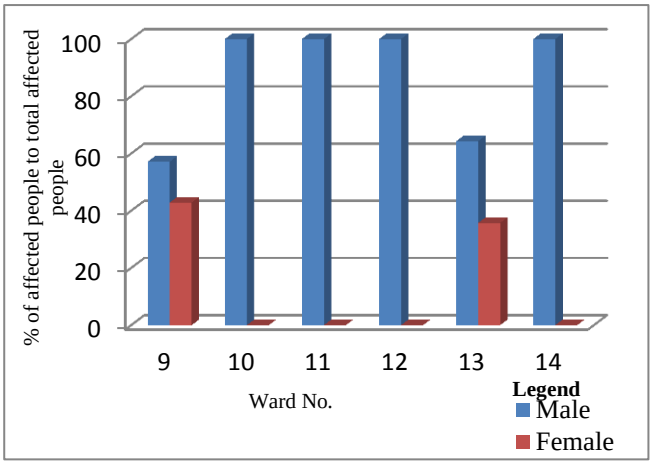
Source: Field survey (2017), Sample households: 100.

Gender wise Arsenic affected people: In the study area of Beldanga Municipality 7.24% males to total surveyed people are affected from Arsenicosis, where just 1.93% females to total surveyed people are affected (Table No. 7, Fig. No. 12). The affection rate is varying in six wards, in ward no. 9 and 13 females are affected. 78.94% males are affected to total affected people in the study area, where just 21.06% females are affected to total affected people (Table No.6). In ward no. 9 and 13 are affected females. 100% males are affected to total affected people in ward no. 10, 11, 12 and 14(Table No.8, Fig. No. 13).



Source: Field survey (2017), Sample households: 100.

Fig. No. 12: Ward wise % of Male and Female arsenic affected people to total surveyed people.



Source: Field survey (2017), Sample households: 100.

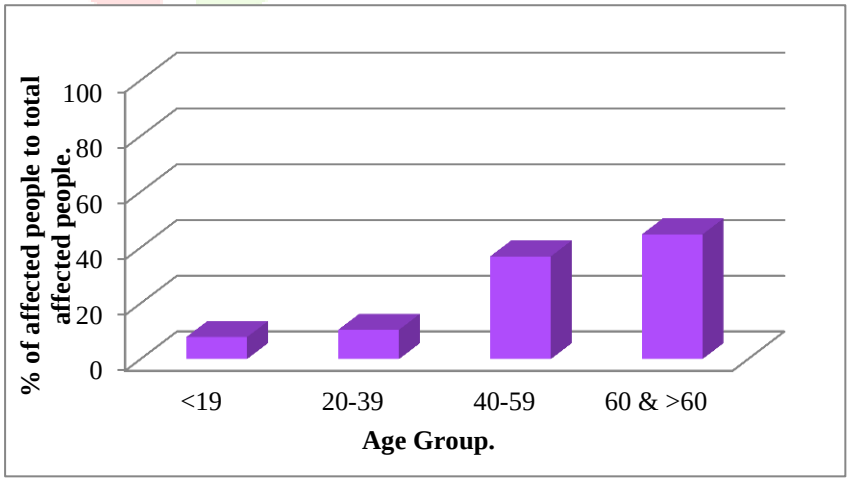
Fig. No. 13: Ward wise % of Male and Female arsenic affected people to total arsenic affected people.

Age Group wise affected people: According to age group in 60 &>60 years people are much affected from Arsenicosis, with 44.73% to the total affected people. 36.84% people of age group 40-59 are affected from Arsenicosis. 7.89% and 10.52% people are affected from arsenic pollution of age group respectively <19 and 20-39 years (Table No.9, Fig. No. 14).

Table No. 9: Age Group wise affected people.

Age Group (years)	Total affected people	% to total affected people
<19	3	7.89
20-39	4	10.52
40-59	14	36.84
60 &>60	17	44.73
Total	**38**	**100**

Source: Field survey (2017), Sample households: 100.



Source: Field survey (2017), Sample households: 100.

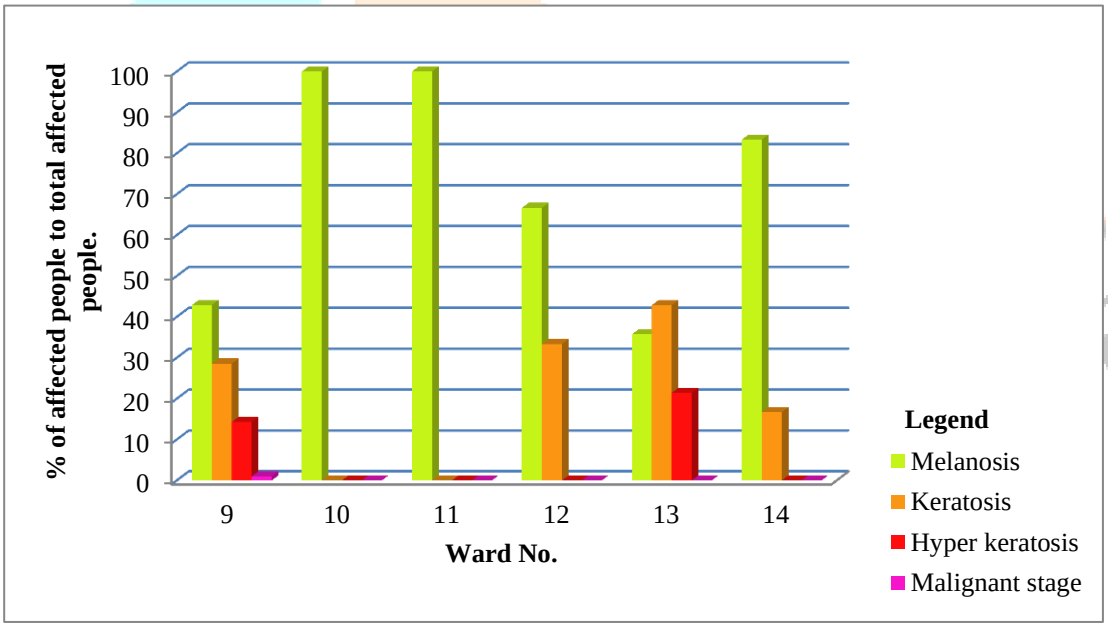
Fig. No. 14: Age Group wise arsenic affected people.

Different Stages of Arsenicosis: There are different stages of Arsenicosis, likely- Melanosis, Keratosis, Hyper Keratosis and Malignant stage. The scenario of this four stages are varying in selected Six wards in Beldanga Municipality (Table No.10, Fig No. 15).

Table No. 10: Different stages of Arsenicosis.

Ward No.	Total affected people	% of Arsenicosis affected people to total arsenic affected people							
		Melanosis	Melanosis (%)	Keratosis	Keratosis (%)	Hyper keratosis	Hyper keratosis (%)	Malignant stage	Malignant stage (%)
9	7	3	42.86	2	28.6	1	14.286	1	14
10	3	3	100	0	0	0	0	0	0
11	2	2	100	0	0	0	0	0	0
12	6	4	66.67	2	33.3	0	0	0	0
13	14	5	35.71	6	42.9	3	21.429	0	0
14	6	5	83.33	1	16.7	0	0	0	0
Total	**38**	**22**		**11**		**4**		**1**	

Source: Field survey (2017), Sample households: 100.



Source: Field survey (2015), Sample households: 100.

Fig. No. 15: Different stages of Arsenicosis.

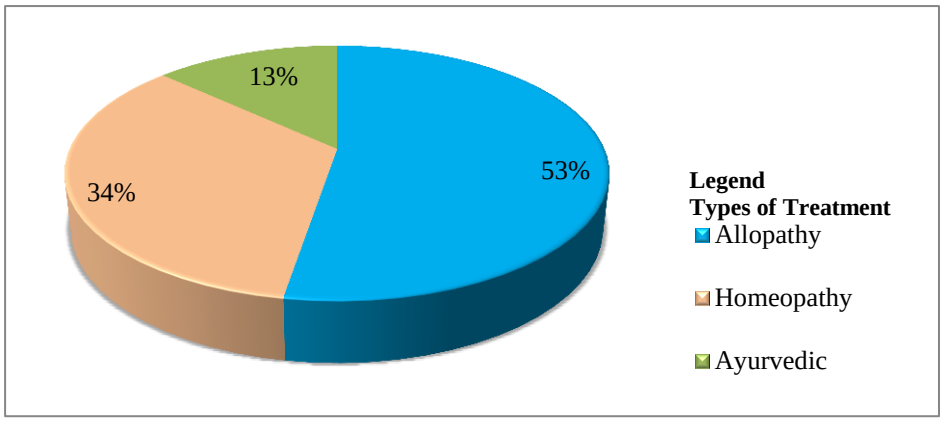
Melanosis stage is found in 57.89% people of total affected people. Keratosis stage is found in 28.94% people, where Hyper Keratosis stage consists 10.52% and just only 2.63% people have cancer or in malignant stage. Only One person suffered from Cancer in the ward no. 9. The highest Melanosis stage is found at ward no. 10 and 11, with 100% of both ward. Keratosis stage mostly found in ward no. 9, 12, 13 and 14, with respectively 28.6%, 33.3%, 42.9% and 16.7% persons. Hyper Keratosis stage mainly occurred in ward no. 9 and 13, with respectively 14.28%, 21.49% persons (Table No. 10, Fig No. 15).

Types of Treatment : 52.63% people of total Arsenicosis affected people preferred Allopathy medication, where 34.21% and 13.16% people respectively preferred Homeopathy and Ayurvedic medication (Table No. 11 Fig. No. 16).

Table No. 11: Types of treatment.

Total affected people	**Types of Treatment**					
	Allopathy	**Allopathy (%)**	**Homeopathy**	**Homeopathy (%)**	**Ayurvedic**	**Ayurvedic (%)**
38	20	52.63	13	34.21	5	13.16

Source: Field survey (2017), Sample households: 100.



Source: Field survey (2017), Sample households: 100.

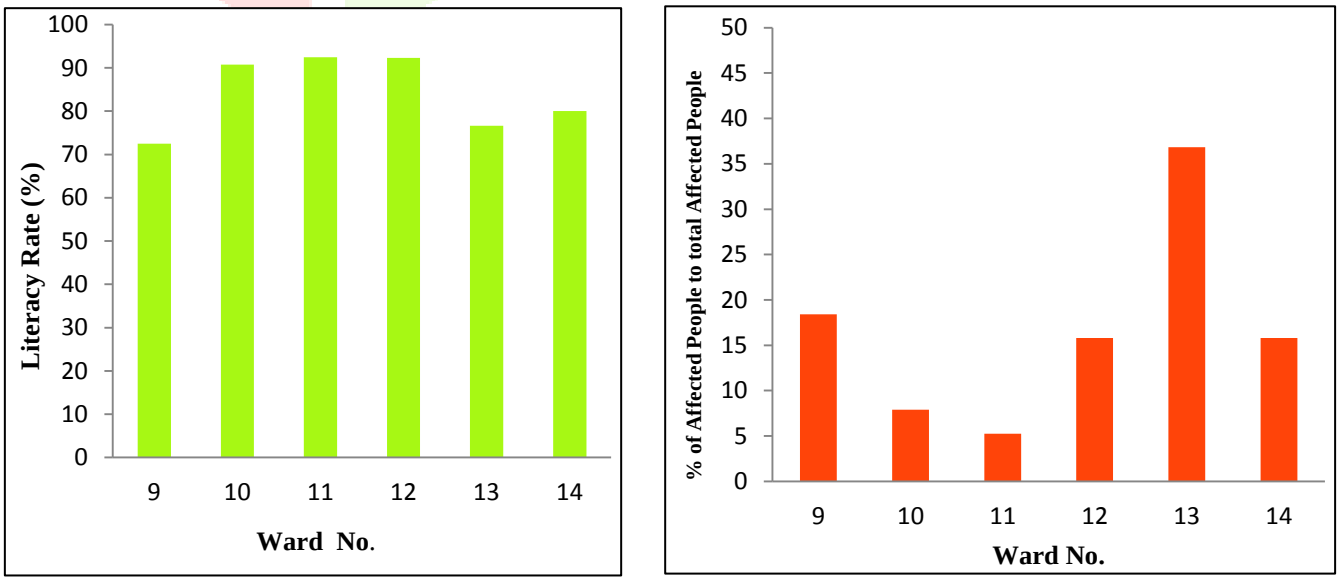
Fig. No. 16: Types of treatment.

Relation between Literacy rate and rate of Arsenicosis: On the basis of Primary survey it can say that the relation between literacy rate and Arsenicosis is Negative. It is found that where the literacy rate is high, the rate of Arsenicosis is low and in case of low literacy rate, Arsenicosis is high. In ward no. 13, the literacy rate is 76.66% and the rate of Arsenicosis is 36.84% of total affected people. In ward no. 11, the literacy rate is 92.45% and the rate of Arsenicosis is 5.26% of total affected people (Table No. 12, Fig. No. 17).

Table No. 12: Relation between Literacy ate and rate of Arsenicosis in the study area, Bedanga Municipality.

Ward No.	Total population	Total Literate Population		Total affected people	Rate (%)
		Total Literate	Rate (%)		
9	80	58	72.5	7	18.42
10	54	49	90.74	3	7.89
11	53	49	92.45	2	5.26
12	65	60	92.3	6	15.78
13	90	69	76.66	14	36.84
14	72	59	80	6	15.78
Total	**414**	**344**	**83.09**	**38**	**100**

Source: Field survey (2017), Sample households: 100.



Source: Field survey (2017), Sample households: 100.

Fig. No. 17: Relation between Literacy rate and rate of Arsenicosis.

MAJOR FINDINGS OF THIS STUDY

On the basis of Household survey of selected six wards in Beldanga Municipality got some findings of the total study. The major findings of the study vare as follows-

a. Most of the cases of Arsenicosis more happened to the higher aged people than lower aged people.
b. Women are less affected than men.
c. In many cases, in many area safe Municipality Tap water are available, but many of the people didn't used the safe water.
d. Lack of consciousness about Arsenicosis of local people. Most of the people heard of Arsenic but they didn't use the safe drinking water.
e. Insufficiency of medical structure, especially about Arsenicosis.
f. Insufficient Laboratories for testing tube well water.
g. In many areas of the selected six wards, there have no facility of Municipality Tap water.
h. The relation between *Literacy rate and the rate of Arsenicosis is Negative*. Where the *literacy rate is high*, the rate of *Arsenicosis is low* and in the case of *low literacy*, the rate of *Arsenicosis is high*.

CONCLUSION

The present study of "*Impact of Arsenic Pollution on Humans in selected wards of Beldanga Municipality, Murshidabad District, West Bengal",* shows the impact of *Arsenic pollution* on human life and discussed the *mitigation techniques with some suggestion* to local people and the government. On the basis of household survey it can say that, although most of the adult population of the total affected people are affected from *Arsenicosis*, it is also found from the study area, that, men are more affected than women. One of the reasons for it is that, many women have come to these wards only after their marriage. Therefore, their symptoms appeared only in the last few years. The adult female population who born in the arsenic affected wards and have used arsenic contaminated water since birth are mainly affected. Though in many wards safe Municipality tap water are available, but many people didn't use the water, this kind of incident happened due to unconsciousness of those people. Besides, in many areas safe drinking water are not available, the Municipality have to increase the water pipeline. In this situation it can say that, by avoiding using of tube well water or using deep tube well with the depth of more than 80m, construction of laboratories for water testing, public consciousness etc can control the Arsenic pollution.

MITIGATION TECHNIQUES

To remove or check arsenic from groundwater some modern and some conventional technologies may apply-

MODERN TECHNOLOGIES

a. In-Situ Remediation: It is the process of decontamination of aquifer from arsenic by physio-chemical and geochemical processes. But this technique is very expensive and requires prior knowledge on the behaviours of aquifer system.
b. Ex-Situ Remediation: By this technique, we can remove arsenic from tapped water. But ex-situ technologies can remove arsenic only from tapped groundwater, not from aquifer system.
c. Use of Surface Water as an alternative Source: This is an alternative method of using arsenic free safe water for domestic and irrigation purpose. Beldanga Municipality is better for these techniques because in the western side of the Municipality river Bhagirathi is flowing and the Municipality also has some ponds within it.
d. Construction of Deep Tube Wells: Deep tube wells having depth of 80m and more can be constructed, which may increase the probability to serve safe water for a long time.

CONVENTIONAL TECHNOLOGIES

These include *oxidation, co-precipitation, absorption, ion exchange and membrane* processes for removal of arsenic from contaminated water. These processes need high efficiency and applicability. But the production of large amount of toxic sludge as by-products is the main disadvantage of these technologies.

SUGGESTIONS

Several mitigation techniques measures have been taken in this regard, but still there is some inadequacy of these efforts, I propose some suggestion to local people and the government -

a. Establish deep tube wells having depth more than 80m.
b. Testing of water whenever new tube well is being constructing.
c. Testing the water of old tube wells at least twice in a year.
d. Municipality have to increase the length of water pipeline.
e. The scope of research facility has to increase.
f. Setting up of local and district level laboratories.
g. Setting up of medical dispensaries.

h. Local government has to growing consciousness among the local people regarding the terrific effect of arsenic pollution.
i. Formation of local NGOs to monitor arsenic pollution.
j. Supply of sufficient funds and support from the Govt. Bodies.

REFERENCES

Acharyya, S. K., & Shah, B. A. (2007). Arsenic-contaminated groundwater from parts of Damodar fan-delta and west of Bhagirathi River, West Bengal, India: influence of fluvial geomorphology and Quaternary morphostratigraphy. Environmental Geology, 52 (3), 489- 501.

"Arsenic in groundwater in india", Bhu-jal News Quarterly Journal, Published by Central Ground Water Board, Ministry of Water Resources, Government of India, Volume 24, No. 2 & 3 (April-Sept 2009): Pp. 6-27.

Bhattacharjee S. (2011): "Age-sex Distribution and Management of Arsenicosis- A case study from arsenic affected South Bengal", Indian Journal of Landscape systems and ecological studies, vol. 34, No. 1, June 2011, Institute of Landscape, ecology & ekistics, Kolkata: Pp. 245-254.

Chakraborti, D., Mukherjee, S. C., Pati, S., Sengupta, M. K., Rahman, M. M., Chowdhury, U. K., Lodh. D., Chanda, C. R., Chakraborti, A. K. & Basu, G. K. (2003). Arsenic groundwater contamination in Middle Ganga Plain, Bihar, India: a future danger. Environmental Health Perspectives, 111 (9), 1194–1201.

Census of India 2011, Government of India.

Ghosh T. and Kanchan R. (2013): "Identification and spatial analysis of groundwater vulnerability zones of Murshidabad district (West Bengal)", Asia-Pacific journal of social science, vol. 3, June-Dec 2013): Pp. 1-38.

Ghosh P. & Ghosh R. (2014): "Arsenic menace in the right bank of Bhagirathi river: A case study of Natungram Village, Ketugram II Block, Barddhaman", Proceeding of International Seminar on Environmental Perspectives and Resource management (19th-20th December, 2014), Organised by: institute of Landscape ecology and ekistics, Kolkata: Pp. 372-376.

Kanchan R. & Ghosh T. (2011): "Groundwater arsenic contamination and health status in Nadia District, West Bengal, India", The Deccan Geographer, Vol. 49, No. 49, June 2011: Pp. 51-63.

Ravenscroft P., Brammer H. and Richards K. (2009): "Arsenic pollution-a Global synthesis", John Wiley & Sons, Ltd, Publication: Pp. 318-355.

Whitacre D.M., Garelick H. And Jones H. (2008): "Reviews of Environmental Contamination and Toxicology, Arsenic Pollution and Remediation: An International Perspective", Springer Science, vol. 197: Pp. 1-17