Introduction

The School of Tropical Medicine, Calcutta, diagnosed the first arsenicosis patient due to consumption of arsenic contaminated water in West Bengal in 1982. Since then more than two lakh people have been estimated as suffering from arsenic related symptoms and some of them are known to have died without proper treatment. Arsenic has been found in ground water in eight districts of West Bengal covering an area more than thirty eight thousand square kilometers and with a population nearly forty million. Around one thousand villages in more than sixty blocks (from eight districts) are arsenic affected and more than two million people are drinking arsenic contaminated water with arsenic content above 0.05 mg/liter (maximum permissible level recommended by WHO). [WHO 1981]

Since the survey began (in 1997), water of tubewells (bore hole hand pump) from the eight districts showed that around 40% of the samples had arsenic content more than 0.05mg/litre. The average concentration of arsenic in the contaminated water is about 0.2 mg/liter. The maximum concentration of arsenic has been found around 4.0 mg/liter (80 times more than WHO recommended permissible level).

According to the concerned geologists and environmental scientists, arsenic poisoning is essentially caused by geological factors but also triggered by human intervention. Arsenic is abundantly found in the sediments as arsenic pyrite (FeAsS) in subsoil iron pyrite (FeS2) rocks. Pyrite is a ubiquitous mineral found in most major subsoil rocks. Geological exploration showed that sedimentation has been going on since the Carboniferous- Permian period (340 million years ago) to the recent time. According to environmental scientists, heavy withdrawal of the ground water was responsible for arsenic contamination. Due to this, the ground aquifer has got aerated from the atmosphere to fill up the vacuum space. Oxygen present in the air was responsible for degradation of arsenic rich sources as it decomposed the pyrite rich in arsenic and the acids released through complex geo chemical reaction transformed arsenic into soluble form in ground water. Gradually it spread along the aquifer to the distant places. Eventually arsenic contaminated water comes out through handpumps and pumps used in irrigation as well.

Over exploitation of ground water was caused by a number of factors, which have been an integral part of the changing agricultural practices of West Bengal, like cropping frequency incremented from once or twice a year to three or even four times a year, increase in the use of land by converting fallow and waste land into agricultural land, changing cropping pattern: new crops (for instance boro rice) require more water for irrigation and lastly increase the dependence on the ground water for irrigation. The traditional mode of irrigation (i.e. rain and surface water) could not meet the need and also lacked state patronage. It is worth noting that during the same period, an important public health policy has been adopted to promote ground water for drinking purpose to prevent water borne infectious diseases like diarrhea, cholera, amebiasis and other
gastrointestinal diseases. Thus change of water source for daily consumption and increase in quantum of water in use has dramatically enhanced arsenic contamination.

After entering the body, arsenic gets widely distributed and affects every system. It affects the skin leading to visible manifestations of pigmentation, de-pigmentation and keratosis. The nervous system, respiratory system and other systems (liver, blood vessels, blood, and pancreas) are also affected. It damages and changes the structure of chromosomes and leads to mutation and carcinogenic changes after prolonged exposure. It crosses placental barrier and may lead to premature labor, spontaneous abortion, and congenital malformation.

After arsenic poisoning being noticed, in almost every village in the affected districts was surveyed by the School Of Environmental Studies (SOES), Jadavpur University Calcutta. It included measurement of arsenic in ground water, depth of water layers, analysis of soil and other geological aspects. A number of epidemiological teams surveyed the different villages in order to examine clinical manifestations and extent of the problem. Department of Gastroenterology of Institute of Post Graduate Medical Education and Research in Calcutta started running a special outdoor clinic once in a week and number of clinical and histopathological tests have been conducted for in-depth research on cellular level manifestation. Treatment protocols have been developed by various experts to save lives of chronic arsenicism patients and monitored to examine efficacy of drugs. Number of water filters has been developed for use at individual, household and community level to provide arsenic free water. A number of international experts including eminent geologists, chemical engineers, epidemiologists, clinicians, biochemists as well as international organizations like WHO, UNICEF, World Bank started to address the problem.

The multidisciplinary research was able to establish the facts regarding geological and development policy responsible for arsenic contamination of ground water, its impact on human and animal physiology and find some solution to reduce disease burden and mortality. Thus the existing research findings have greatly contributed to our understanding of the epidemiology of arsenic toxicity. But several issues remain unexplained or have been partially revealed, especially social determinants of exposure, manifestations and their physical and social consequences. The consequences on people's lives that give 'social meaning' to the problem and lead to devising ways of dealing with it remained unexplored.

Since 1984, research articles published in several national and international conferences, seminars and policy documents by arsenic experts from various disciplines have been confined only within the natural and biomedical sciences. Published documents dealing with social dimensions of arsenic problem were not available. The existing research on arsenic poisoning in the context of West Bengal (also Bangladesh which is also affected by arsenic poisoning and extent of problem in several folds higher than West Bengal) can be divided into two broad categories i.e. i) contamination of ground water with arsenic and it's entry into human body
addressed essentially by geologists and environmental scientists, ii) patho-physiology of chronic arsenicosis and clinical manifestations essentially by clinicians. These gave a clear picture of prevalence, severity of manifestation and dose response relationship, patho-physiology, geological mapping of arsenic spots and efficacy of treatment. But there is wide gap between these two dimensions of research. A few questions remain unanswered, they are as follow: are there any other factors (both physical and social), which modify (i.e. increase or decrease) the entry of arsenic into the human body through arsenic contaminated water and metabolism or its detoxification and elimination from the exposed human body, influencing the extent of toxicity and manifestation in different sub-groups and individuals of the affected population? What are the interlinkages between the factors? Moreover, except biological (i.e. clinical manifestations) no other consequences had been explored. In other words, impact of chronic arsenicosis on the lives of the people in the form of restriction or lack of ability to perform an activity in the manner or within the range considered normal for a human being, the disadvantages which limit or prevent the fulfillment of a role that is normal (depending upon the age, sex, social and cultural factors) and the impact on social life and well being of the afflicted individuals and the community had not been explored or documented. People's perceptions and actions in relation to the problem also remained unknown. Thereby the preventive and control measures only adopted a biomedical, technocentric approach.

There are some narrated stories of hapless arsenicosis patients and their families published in various news papers, which gave a glimpse of the impact on people's lives. Various media reports have highlighted the extent of government apathy, people's anger and frustration. But their issues have never been given space in academic discourse and public health planning. The existing studies regarded the society as homogeneous and arsenic level of ground water source has been taken as magnitude of toxic exposure of individual. But as a matter of fact, even in any tiny village, the society bears heterogeneous character in terms of class, caste, gender and so on. Water consumption pattern also varies according to occupation, class, gender; season and therefore domestic source alone can not be the indicator of contamination. A few studies superficially mentioned the influence of poverty, nutrition and gender on clinical manifestation but these have never been explored further to discover the process and inter-linkages among the various social factors. It is worth mentioning that there are a number of publications in the field of public health where social dimensions have been considered key factors in determining the extent and distribution of major infectious and non-infectious diseases.

Arsenicosis is not confined to West Bengal and Bangladesh but several other countries like Taiwan, Thailand, Inner Mongolia (China), Pakistan, Japan, Sweden, UK, USA, Canada, Chekoslovakia, Chile and many other countries as well. Unfortunately all the researches followed the same pattern i.e. geochemical, physical and environmental nature of arsenic exposure and clinical manifestation along with histopathological studies. No epidemiological researches could
come out from these boundaries and attempt a wider perspective covering social dimensions of the problem.

This nature of epidemiological research on arsenic reflects the state of epidemiological research of present days. According to Mervyn Susser, modern epidemiology has shifted from the population level analysis to individual level and such epidemiology lacks integration with other public health activities. [Mervyn Susser 1987] Hence modern epidemiologists have neglected social, economic, cultural, historical, political and other population factors. Modern epidemiologists rarely consider socio-economic factors and population perspective, except perhaps to occasionally adjust for social class analysis of the health effects of tobacco smoke, diet and other life style factors in individuals. Epidemiological research on arsenic followed the same trend. Therefore the need was felt to address the social dimensions related to chronic arsenicosis, in a wider perspective.

The social epidemiological approach has been adopted to examine the social determinants influencing the extent and distribution of arsenicosis in the areas with arsenic contaminated water and the social consequences of physical manifestation of arsenicosis. By definition ‘social epidemiology’ is the study of the relations between social factors and diseases in the population. In other words, it is an approach and a method, which provides foundation for researching and understanding the contribution of social factors and processes to the pattern of health and illness in populations. Social epidemiology utilizes the social survey methods including retrospective and prospective designs to determine the “causal” relationship between social factors as the independent variables and disease states as the dependent variables, examination of social construction of health and its implication for measuring morbidity. In essence to develop models that explain how social factors act as causative agents. Moreover social epidemiology deals with the influence of social, behavioral, cultural and demographic factors on disease process and consequences at population level. By definition epidemiology is “the study of the distribution and determinants of health related states or events in specified population and application of this study to control of health problems”. Indeed every epidemiological variable can be in some sense a sociological variable. The factors affecting the distribution of disease in populations have social implications. The populations to whom the biological dimensions refer are not mere aggregation of discrete individuals. They comprise, as groups of people with some order of relationships between them, the elements of society. The environment that contains the populations is equally a facet of society in its physical and biological as well as its social components, civilization, however primitive is natural environment modified by human groups [Mervyn Susser 1987, Terris M 1979]. But modern epidemiological research limited itself with its physical and social aspects of health at the individual level. This kind of modern epidemiology has had limited success to address illness pattern, causes and consequences in the community; so there has been renewed effort to integrate the epidemiological and social science dimensions.
An interdisciplinary approach to study the social epidemiology of arsenic poisoning in West Bengal was therefore adopted. The study examined the social factors influencing levels of exposure, manifestations and consequences. Data collection was undertaken in five villages of Domkol block of Murshidabad district in West Bengal. Using a cross sectional survey for prospective and retrospective study, chemical analysis of water, nutritional assessment and clinical examination was done. Several methodological innovations had to be made. These related to categorization of population by socio-economic status, measurement of amount of intake of arsenic and categorizing the consequences of this exposure to arsenic. Socio economic categories were constructed based on participatory assessment of local context. Measurement of exposure was done individually taking occupation, source of domestic water and at work and the intake of water.

In order to study the consequences of chronic arsenicosis, WHO’s International Classification of Impairment, Disability and Handicap (ICIDH) was used. According to WHO, disease or disorder is followed by three consequent planes i.e. impairment, disability and handicap. Impairment, disability and handicap are exteriorization, objectification and socialization of disease or disorder respectively. In the study of social epidemiology, this conceptualization was thought to be extremely relevant as the consequences of any disease process are not only physical but also social. Further, the two are modulated by the physical and social situation of the individual and his ecological context. This includes not only the physical and biological but also the social structures, economic and political conditions and cultural milieu of which the individual is a part. But it is important to note that WHO’s ICIDH is not a foolproof tool. It cannot be strictly universally applicable in all diseases. But there is scope to modify according to need. Many studies on other health problems have earlier adopted WHO’s ICIDH and modified it according to the context. [Gunner Gimbly 1988, Mary Chanie 1989, Alaranta 1986, Jane Finstram 1989, Yvonne 1995, Gomez Rodriguez 1989] The expert committee that formulated ICIDH also suggested changes according to the situation. In this study too, modifications were made as found appropriate, and the extent as well as determinants of impairment, disability and handicap due to arsenicosis examined in depth.

Arsenic contamination in ground water is essentially a developmental issue that is the outcome of unsustainable agricultural and water supply policies. The irrigation policies which have been motivated by a technocratic approach and simultaneous systematic elimination of traditional knowledge and know how has led to this serious and complicated public health problem in recent times. This study has documented the physical impairment; various kinds of disability and handicaps caused by chronic arsenicosis in the study villages. Analyzing these against the social characteristics of affected persons, and the interventions undertaken to deal with the problem, it was found that poverty, coupled with malnutrition, powerlessness, gender discrimination, absence of social security, illiteracy, and corruption in every layer of state machinery aggravated the
situation. A virtually defunct rural health service and centralized health policy could not provide any tangible relief to the vast majority of the exposed population who are living in the rural area.

The thesis is divided into two sections. First section begins with a review of literature leading to conceptualization of the study. It elaborates upon the chronic arsenic poisoning, social epidemiology and consequences of diseases and is then followed by study design consisting of theoretical framework of the existing problem. The next section deals with analysis of the data divided into four chapters i.e. village and household situation, impairment, disability and handicap. Each chapter is not isolated from the others; rather they are all closely inter-linked to provide a comprehensive picture. The first chapter of data analysis contains essentially qualitative data as description of various aspects of social profile of the study area along with direct estimation of various findings like demographic and socio economic variables of study villages. In the chapter of impairments and determinants, linkages between various social factors with exposure level and manifestations are established. Socio-economic status, occupation, gender, religion and caste, are included as social factors. Exposure levels, nutritional status and treatment are related physical variables. There is establishment of linkages among the various social and physical factors in order to redefine the complexities of relationship and to find out how these relationships are contributing in exposure and manifestation as well. The last two chapters of data analysis include impact of manifestation as disabilities and handicaps. The relationships between impairment and disability, disability and handicap and impairment and handicap are analyzed in the context of the local life pattern and complex social dynamics. The four chapters of data analysis have contributed to delineating causal relationships regarding extent, distribution and impact of chronic arsenicosis along with the response of the problems. Lastly all methodological issues and findings are brought together in the discussion to draw implications for policy.