# Environmental Pollution from Rural Brick-making Operations and Their Health Effects on Workers

*-------Research Design*


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## 1. Background Reviews

Brick is an ideal material for structures in confined spaces, as well as for curved designs. Moreover, with minimal upkeep, brick buildings generally last a long time. For that, brick is a major building material in many developing countries, especially in China，India and Vietnam . Bricks are one of the most important building materials used in China，especially in the rural areas. Almost all the buildings use bricks as a major building material. In recent years, with expanding urbanization and increasing demand for construction materials, brick kilns have grown both in numbers and capacity in china. China dominates global brick production (~54%). The brick kiln industry is the largest producer in the world, has more than 73,000 operating units, producing about 900 billion sintered bricks annually, among which about 50% are fired clay bricks (by 2008 year). The fired clay brick making is one of the traditional handicraft industries and has a history of more than 2000 years in China.

It has directly or indirectly caused a series of environment and health problems. (See, Figure1). At a local level (in the vicinity of a brick kiln), environmental pollution from brick-making operations is injurious to human health, other animals and plant life. At a global level, environmental pollution from brick-making operations contributes to the phenomena of global warming and climate change. The manufacture of fired clay bricks includes: mining, crushing, screening, forming and cutting, drying, kiln loading, firing and kiln unloading and shipping (See,Figure2).

During the firing process, a large amount of fuel is consumed to maintain a high-temperature from 1600 ºF to 2400 ºF. The fuels usually are coal, wood, crop residues, natural gas or oil. It may cause serious air pollution and negatively influence human

health. In China, the sintered clay brick kilns to fire the bricks mainly use coal while wood, crop residues and animal dung are used in some countries like Nepal, India, Thailand and Sudan. Some developed countries like the U.S. use natural gas or oil as fuel to fire the bricks. Use of coal as fuel to fire the bricks results in the release of many kinds of air pollutants in the atmosphere， such as, carbon dioxide ($CO_2$) , carbon monoxide (CO), sulphur dioxide ($SO_2$ ), nitrogen oxides (NOx), fluorides, and particulate matter, etc. Those pollutants spread out around quite a large area near the fields and

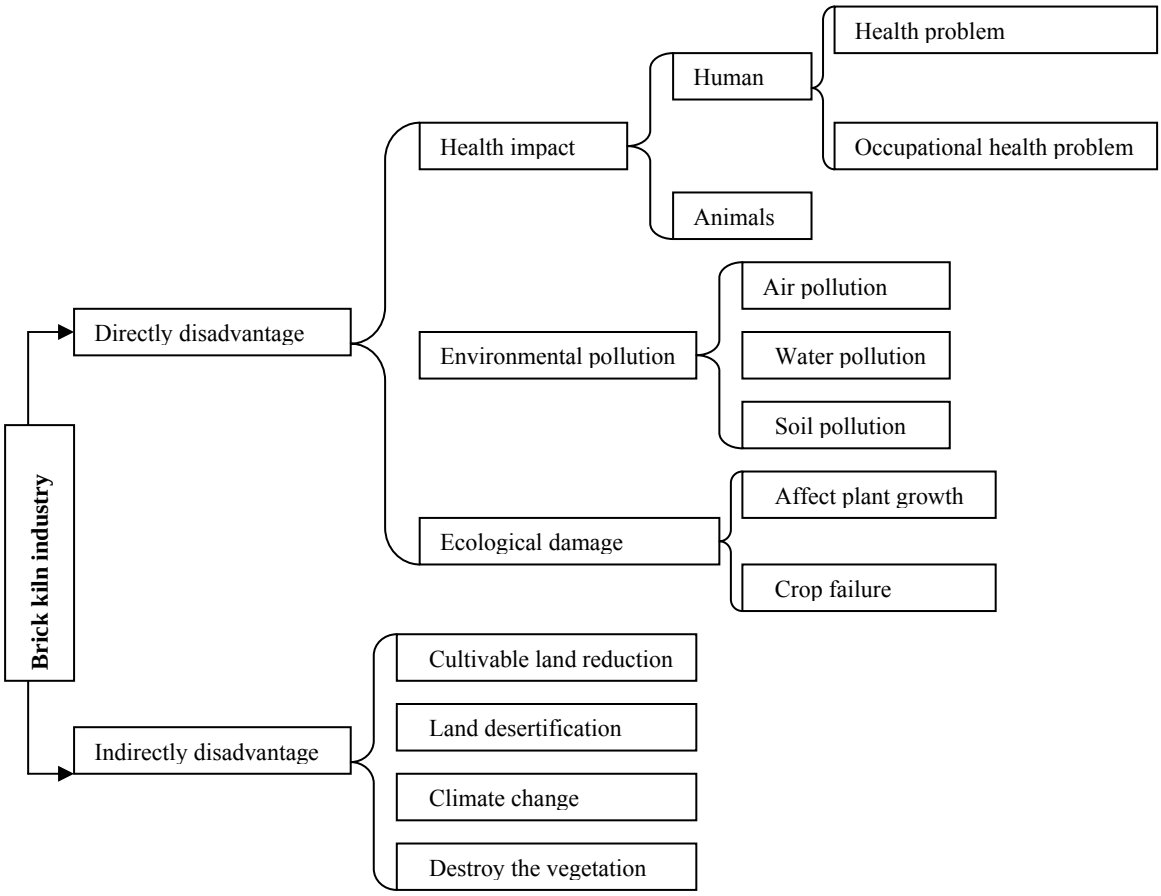


**Figure 1. The disadvantages of brick-kiln industry**

deteriorate ambient air quality. Those people who live in the area nearby the brick kilns are always at risk of exposure to the pollutants, and workers who work and live in the brickfield are the highest risk people. Epidemiological studies done in different places around the world have found increases in the prevalence of bronchitis, asthma, decreased lung function, pharyngitis, cough, eye irritation, pulmonary fibrosis, emphysema, allergic rhinitis, low birth weight that are linked with deteriorating ambient air quality. Moreover,

the thick layer of dust deposited on the leaves of crops and trees blocks the photosynthetic process. In addition, some pollutants may deposit in the soil and cause plant diseases and even death, which may bring about lower agricultural yields and destroy the vegetation if continued for a long time. Some pollutants can do harm to the health of animals, result in higher death rates of domestic animals (e.g. chickens) that live nearby the brick field.

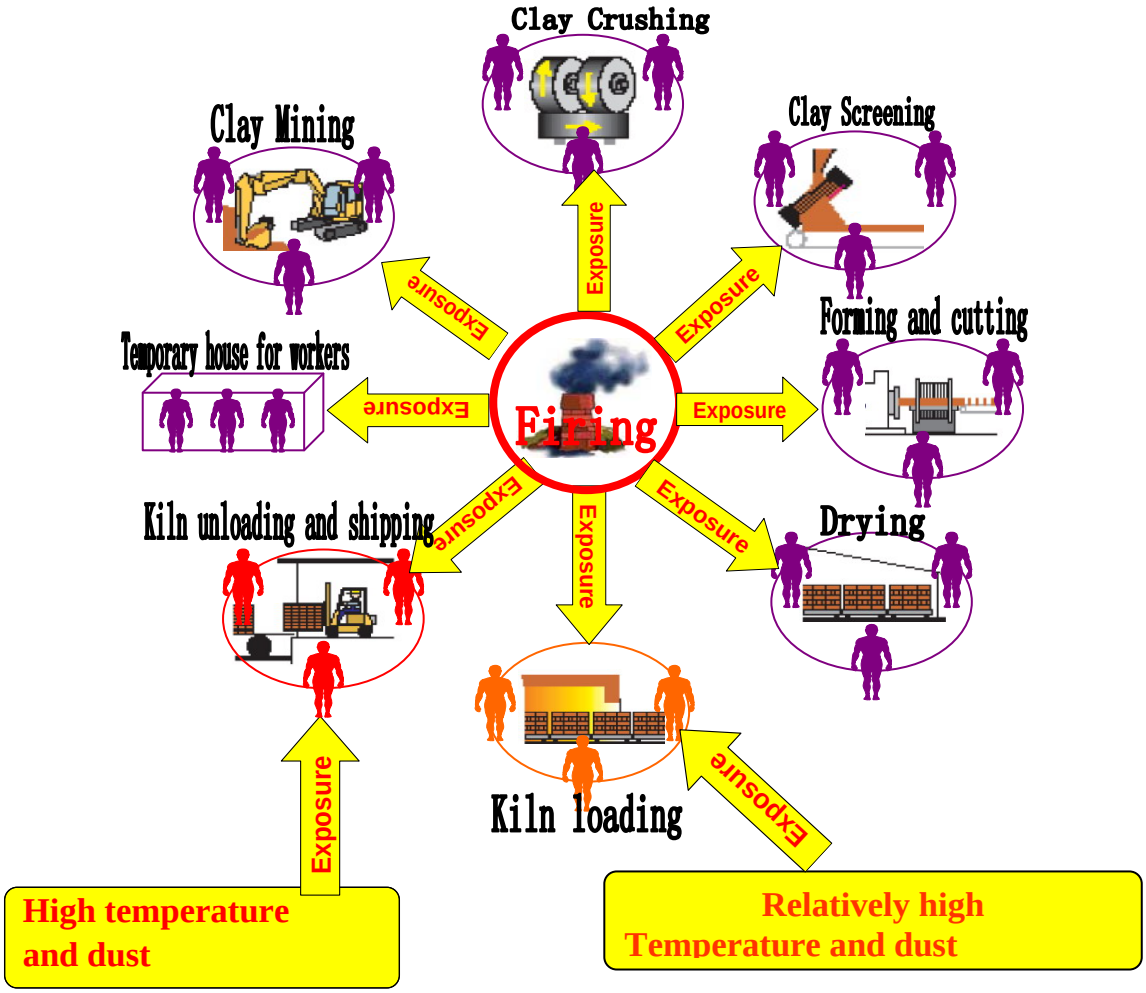


**Figure 2.The brick-making process and the exposure of workers**

During the kiln unloading and shipping process，it may produce a lot of dust and particulate matter pollutants that come from the surface of the bricks and have the same chemical components as brick itself. These main chemical components are $SiO_2$, $Al_2O_3$ and $Fe_2O_3$. Due to different geological formation conditions, components may also contain a small amount of alkali metal and alkaline earth metal oxides. The kilns are a

semitight environment and the average temperature in the kilns are from 50ºF to 77ºF （10 ºC to 25ºC） higher than out of the kilns. Work exposure to the high temperature and the high density dust and particulate matter over a long time can result in occupational health problems, including serious disease (e.g. lung cancer).

Gansu province, located at the northeast of China, belongs to the Loess Plateau with the richest clay resources. There are a number of clay brick–kilns in the rural parts. The clay brick kiln industry plays an important role in the economic development and urbanization of Gansu province. Because of the limitation of the local economy and culture, most brick kilns are small or medium sized, lag in technology for production and management, are poorly designed without scientific input, inefficient and high pollution emitters. As a result, the environmental pollution and relevant health problems from brick kilns are more serious than other areas. With growing environmental and health consciousness at all levels of society, those problems caused by the brick industry are coming under close scrutiny from the public and the government. But as a matter of fact, there are very few studies done to date. It is, therefore, worth exploring and researching this topic.

## 2. Project Objectives and targets

2.1 This project try to through those methods of field investigation, interviewing，using monitoring equipment and Laboratory analysis to collect information on the types of major pollutants from brick-making operations in rural of Gansu province, to learn their concentrations, pollution range etc, summarize and analyze those data and given a evaluation on the status of environment pollution in light of relevant regulations and standards.

2.2 Through questionnaire survey , medical inspection, interviewing and inspecting relative health recorder to get the data on the health of workers and to analyze and evaluate their health condition and to identify the main health problems of workers in brick-kilns.

2.3 Utilize an epidemiological approach to examine and study the relationship between the health problems of workers and their exposures to environment pollution

from brick-kilns. Make a clear understanding of the problem for workers and the owners of the brick-kilns.

2.4 Through actual operation of this project to provide basis for the government to prevent and control the environmental pollution from brick-kilns, to conduct personal protection of workers in this industry, finally, to raise environmental awareness amongst the general public and to push ahead the innovation and reforms of brick-making industry in China.

## 3. Research Contents

3.1 Conduct air pollution (TSP, PM10, COx, SO2, NOx) monitoring of brick filed, the ambient and workers rest rooms during operating and not operating periods of the brick kilns.

3.2 Conduct indoor air pollution (TSP, PM10, PM2.5, COx, SO2, NOx) and meteorologic condition (temperature, humidity) monitoring in the kilns.

3.3 Sample the soil and water around the brick-kilns and to do pollutants test (Fluorine (F), Heavy Metal).

3.4 Conduct questionnaires survey and interviews about workers' health conditions and other related information.

3.5 Health response assessment which includes review the medical record and other related health record of workers, pick and record that useful information, At the same time, conduct some necessary medical examination for them, mainly include respiratory system examination, eyes examination, heart examination, skin examination and blood pressure measuring.

3.6 Base on the above information， conduct an epidemiological method of cross-sectional study to find the relationship between the health problem of workers and the exposure to the environment pollution from brick-kiln.

## 4. Epidemiological Design

### 4.1 Sample of Brick-kilns

Through website and related government departments, I will obtain the directory of

the brick kilns within the area under the jurisdiction of Lanzhou including Gaolan County，Yuzhong County and Yongdeng County (over 100 brick kilns are named on the list). I will pick those brick kilns that meet the following conditions: rural location，vertical shaft continuous kiln design, over 50 persons total workers, over 500,000 bricks annual production and over 200,000kg annual coal consumption. According their geographic location I will divide them into four sections: Yuzhong county, Yongdeng county and the suburban district of Lanzhou respectively. I will sample two brick kilns from each section respectively by random sampling to finally get eight brick kilns as the research sites.

## 4.2 Human Subjects Selection and Grouping

### 4.2.1 Human Subjects Grouping

All of the workers who are working in the sampled brick kilns who have worked on the job over 6 months should be defined as exposed no matter what gender, job categories and age groups. Those workers who have exposure should be put into three groups on the basis of exposure level. Unloading workers should be defined as the first-high risk groups (exposure to not only pollutants from the kiln chimney but also the high temperature and dust); loading workers should be defined as the middle high risk groups (exposure to pollutants from the kiln chimney and relative high temperature and dust); other job categories workers should be defined as the low risk groups (exposure to only pollutants from the chimney of the kiln). Considering most workers are local farmers and come from the Village around the brick-kilns, so control group will be selected from local farmer population.

### 4.2.2 Sampling method and sample size

The target sample size was determined after consideration of several requirements: the power of statistical test was set as 80%, the statistical significance level alpha was set as 0.05, the symptom prevalence estimates ranged from 0.2-0.3, and at the same time, considering the funds available and the feasibility in practice, sample size needed per group are 80 people. Supposing loss to follow-up are 10%, the final total sample size was determined to be 264 people.

The method of stratified random sampling will be used: first worker whose age is 18~50 years old will be identified in each brick-kiln, categorizes them into the three exposure groups (first-high risk groups, the middle high risk groups, low risk groups) and divide each group into two subgroups by gender (male subgroup, female subgroup), then randomly select 6 people from each subgroup. The control group will be selected from the local farmer population: Cluster sampling method will be used to sample one village around each brick-kiln, People whose age is 18~50 years old will be identified, controls will be age (5 age groups), genders and living habit ( weather smoker or alcoholic) matched with brick-kiln cases.

### 4.3 Research Method

4.3.1 Sample test in field

Portable atmospheric sampling meters and powder-dust sampling meters will be used to sample and monitor the concentration of all kinds of pollutants (TSP, PM2.5, PM10, COx, SO2, NOx) during operating and not operating periods of the brick kilns. All sampling meters will be calibrated before use. Selection of monitoring point will be determined by the practical situation of each brick-kiln.

4.3.2 Laboratory analysis

Soil and water around the brick-kilns will be measured for pollutants, especially the fluorine and those heavy metal pollutants, in laboratory,.

4.3.3 Questionnaire survey

A questionnaire will be designed to survey and collect worker's health conditions and other related information. The questionnaire design will be reviewed by epidemiology experts and it will be amended and improved several times. Before the investigation begins, a preliminary survey will be done to validate and revise the questionnaire.

4.3.4 Physical examination

Physical examination for workers will be conducted in a local hospital by uniform criteria. Diagnosis of related disease will accord with the international classification and diagnostic criteria. The same physical examination will be done for control group people.

### 4.4 Data Analysis and Assessment

Quantitative data will consist of descriptive summary statistics and $\chi^2$ and other analyses done using SPSS 16.0. Statistical analysis and comparison will be conducted between different exposure level groups and different gender groups. Furthermore, it is important to compare the difference of concentration of pollutants in different operating periods. I will try to find the statistically significant symptoms and diseases prevalence among the groups and to understand the relationship between the health problem of workers and the exposure to the environment pollution.

### 4.5 Quality Control

In order to obtain high-quality data and to ensure the validity of the research, quality control will be run through out the investigation.

（1）Quality control before the beginning of the survey

All of the researchers and investigators must receive unified training before starting the investigation to standardize the method of inquiry for each question of the questionnaire. Though group discussion and pilot survey we try to ensure each question is clear and easy to understand for the interviewee. All equipment and meter must be inspected and calibrated to ensure they are in the good working condition before use. The equipment or meter must be same type and model. Accuracy and precision are assured with blank and standard specimens if appropriate. All of investigators will be trained on how to use them normatively in the survey until each of them knows it very well.

（2）Quality control while surveying

Each of the investigators must follow the uniform procesures while surveying. In order to reduce the loss to follow-up and try to maximize participation, subjects will be offered a useful gift, such as a personal hygiene item. Each interviewee must be treated friendly, mannerly, equally and fairly and the responses must be put into the questionnaire promptly and exactly. Physical examination will be conducted by uniform criteria in the morning before breakfast (empty stomach). Diagnosis of related disease will accord with the international classification and diagnostic criteria.

（3）Quality control for data entry and analysis

In the data entry phase, double data entry technique, response range limitations and illegal response detection will be used to guarantee the accuracy of data. The method of stratified analysis will be used to reduce the affect of the confounding.

### 4.6 Feedback the Findings to the Brick-kiln Owners and Workers

After the research project is finished, we will provide feedback to the brick-Kiln owners and workers on the results. It should include some details about the pollution situation around the brick-kilns and the health condition of each investigated worker. Clear explanations will be available for anything they don't understand about the feedback.

### 4.7 Advice for Personal Protection and Environmental Protection

For the purpose of workers health care and environment protection, suggestions for personal protection and environment protection will be made based on the results of the project. I will conduct health and environmental conservation education for workers and brick-kiln owners. In additional, we will print and hand out written information on brick-kiln environmental pollution and health. Accordingly, it may strengthen the awareness of personal health care and environmental protection.

## 5. Project Period and Schedule

**Project Period：** 6 months

**Schedule：**

(1) April 1-5, 2011: Investigator Training Workshop

Training will include the following:

1) Overview of the research project and research design issues.

2) Investigation technique used in the questionnaire investigation

3) Demonstrate the operation of related instruments

(2) April 6-10: Select a small brick-kiln in Lanzhou to carry out preliminary survey and finalize the questionnaire

(3) April 11-20: Contact the owners of selected brick-kilns and visit the localities

(4) April 20-25: Rent bus and preparations necessity, material and instrument for the

spot field investigation

(5) April 26- July 30: Site investigate and research in those sampled brick-kilns

(6) August 1-30: Data reduction, entry and quality control

(7) September 1-30 Statistical analysis and report preparation

## 6. Work Team：

(1) Xiaoheng Wang，Master degree, instructor of NUN (Northwestern University for Nationalities), studies on indoor-air pollution and water pollution. He will be the primary investigator taking responsibility for the report preparation, the oversight, and implementation of the project.

(2) Prof. Yu Guowei, PhD of epidemiology and health statistics , is the director of the Institute of Environment and Health in Western China, NUN. She will provide expertise in project implementation, data collection and statistical analysis.

(3) Hong Lu, Master degree, doctor of the first hospital of Lanzhou University, she will responsible for contacting with local hospital and coordinating the physical examination, to write and explain the feedback of the health condition of workers.

(4) Prof. Ma Liyang, Bachelor's degree, chief of the teaching and research section of preventive medicine, studies preventive medicine and epidemiology. He will provide statistical analysis support after data collection is complete.

(5) Hongmei QU, Master degree, instructor of NUN, studies environmental epidemiology, she will be the primary investigator taking responsibility for the data collection and entry.

(5) Six medical students of NUN (To be determined), they will be the questionnaire administrators.

## 7. Perspective

In the future, we will follow up those workers and carry out further research about the relationship between exposure and health problems of workers of brick-kilns and seek to make clear the risk of the pollution from brick-kilns. We will help owners conduct health education and action intervention for workers thereby reducing the exposure and

promoting health of workers. If it is possible, we will work hand in hand with Lanzhou environmental administration agency to build the management, monitoring, and evaluation database on environment pollution from brick-kilns. It is our duty to guide government to enhance the supervision of brick-kilns, so as to prevent and control the environmental pollution.

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## 9. Project Budget

Unit： 11350 U.S. dollar

| No | Budget Items | Outlay Application Number($) |
|---|---|---|
| 1 | Physical Examination fee | $7600 |
| 2 | Laboratory reagent | $200 |
| 3 | Equipment | $500 |
| 4 | Transport Cost | $650 |
| 5 | Board | $700 |
| 6 | Interviewer Remuneration | $700 |
| 7 | Communication Cost | $100 |
| 8 | Questionnaire Printing Cost | $100 |
| 9 | Data analysis | $300 |
| 10 | Others Cost | $500 |
| Total: $11350 | | |

Some project budgets are explained as follows：

1. Physical Examination fee:

    1. X-ray chest film ----------￥40

2. Electrocardiogram ----------￥35

3. Examination of eyes ----------￥30

4. Pulmonary function tests ---------￥40

5. Routine test of blood ----------￥30

6. Routine test of urine----------￥20

￥195/person*264person=￥51480≈ $7600

2. Transport Cost: ￥550/day*8day=￥4400≈ $650

3. Board: ￥60/day/ person*10persen*8 day=￥4800≈ $700

4. Interviewer Remuneration: ￥60/day/ person*10person*8 day=￥4800 ≈ $700

**Attachment: questionnaire (next page)**

## Survey ID: □□□□ *Date* ___/___/___

The purpose of this questionnaire is to see whether you have any health problems. It is for research purpose only. Please help us to help you by completing the questionnaire as fully as possible. Your answers will be kept completely confidential and only be presented in summary formats.

**Instruction: Check the answer you choose by use "○" （e.g. ①）or fill in the blanks.**

### General Information:

1. Name of the Interviewee: _____ 2. Gender: 1 Male 0 Female

3. Age: Years _____ 4. Telephone#: _____

### General Health Information:

1. Weight _____kg 2. Height _____cm 3. BP: _____mmHg

4. Respiratory frequency_____/min 5. Rhythm of the heart _____/min

### Work-related Information:

1. Job categories: 1 Unloading worker 2 Loading worker 3 Others

2. Starting date of employment in this brick-kilns ___/___/___.

3. Have you ever worked in other brick-kilns 1 Yes 2 No if yes, how long did you stay_____, Job categories: 1 Unloading worker 2 Loading worker 3 Others

4. How long did you worked each day on average _____h.

**5.** Did you wear dustproof mask when working? 1 Yes 2 No

6. Did you wear tight-fitting eyeglasses when working? 1 Yes 2 No

**7.** Did you wear coverall when working? 1 Yes 2 No

8. Did you wear glove when working? 1 Yes 2 No

## Living habit:

1. Which one are you of the following?

   1 Non-smoker

   2 Smoker: Year started How many per day_____.

   3 Ex-smoker: Year started___ Year stopped_____ .

2. Which one are you of the following?

   1 Non- alcoholic

   2 Alcoholic: Year started_____ , how often units_____ ,

   how many units_____ml?

   3 Ex- alcoholic: Year started_____, Year stopped_____.

## Health problems:

1. Do you often suffer from or have you ever had any of the following symptoms lasting at least three weeks in the last six months?

| **Health Problems** | **1Yes** | **2 No** | If yes, what is the time of first occurrence? |
|---|---|---|---|
| Shortness of Breath /Wheezing | | | ___/___/___ |
| Cough | | | ___/___/___ |
| Cough up phlegm | | | ___/___/___ |
| Coughing up blood | | | ___/___/___ |
| Chest Pain | | | ___/___/___ |
| Chest tightness | | | ___/___/___ |
| Chronic bronchitis | | | ___/___/___ |
| Eye irritation | | | ___/___/___ |
| Red eyes | | | ___/___/___ |
| Tending to tears | | | ___/___/___ |
| Dry throat | | | ___/___/___ |
| Throat pain | | | ___/___/___ |

| | | | |
|---|---|---|---|
| Dry nose | | | ___/___/___ |
| Rhinocleisis | | | ___/___/___ |
| Feel dizzy | | | ___/___/___ |
| Frequent headaches or migraine | | | ___/___/___ |
| Nausea | | | ___/___/___ |
| Sleeplessness | | | ___/___/___ |
| Loss of appetite | | | ___/___/___ |
| Skin Itchy | | | ___/___/___ |
| Skin peels (particularly hands, arms and face) | | | ___/___/___ |
| Heart murmur/Palpitations | | | ___/___/___ |
| Bone-arthrosis pain or stiffness. | | | ___/___/___ |
| Menstruation disorder (female only) | | | ___/___/___ |
| Miscarriage/Abortion (female only) | | | ___/___/___ |
| Other symptoms:<br>_____, _____,<br>_____, _____,<br>_____, _____. | | | |

2. Do you have or have you been diagnosed with a disease of the following in the last three years?

| Disease | 1Yes | 2 No | If yes, what is the date of being diagnosed? |
|---|---|---|---|
| Pharyngitis | | | ___/___/___ |
| Pneumonias | | | ___/___/___ |
| Rhinitis | | | ___/___/___ |
| Dermatitis | | | ___/___/___ |
| Heat stroke | | | ___/___/___ |

| | | | |
|---|---|---|---|
| High blood pressure | | | ___/___/___ |
| Allergy | | | ___/___/___ |
| Dental fluorosis | | | ___/___/___ |
| Osteoproliferation | | | ___/___/___ |
| Tuberculosis (TB) | | | ___/___/___ |
| Heart disease | | | ___/___/___ |
| Cancer | | | ___/___/___<br>If yes, what is the category of the cancer_____ . |
| Other disease：_____, diagnosed date ___/___/___.<br>_____, diagnosed date ___/___/___.<br>_____, diagnosed date ___/___/___. | | | |

Signature_____(Responsible Investigator)

***Thanks so much for your cooperation!***

Northwestern University for Nationalities

West of China Institute of Environmental Health