The Impact of Industrial Waste on Human and Natural Resources: A Case Study of Khartoum North Industrial Area

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Dedication

To My Parents
   My Brother
      And My Husband ...
تم إجراء هذه الدراسة لتوضيح الآثار البيئية و الاقتصادية الناجمة عن التلوث البيئي من جراء المخلفات الصناعية الضارة و المتخلص منها دون إجراء أي معالجات.

الطرق التي استخدمت في جمع المعلومات تشمل الاستبيانات و المقابلات الشخصية و التقارير المُ khuẩn عليها من الجهات ذات الصلة و المسؤولية. وكان الاستبيان هو الطريقة الأساسية التي اعتمدت عليها الدراسة.

تم اختيار المنطقة الصناعية جري كعينة لإجراء الدراسة، و تتبع المخلفات من المصدر إلى المصب النهائي لها. أجريت الدراسة على 60 شخص من قاطني المنطقة تم اختيارهم عشوائياً.

هدف البحث هو معرفة مدى تأثير المخلفات على البيئة مسببة سلسلة من الأضرار تؤدي إلى ظهور أشكال التصدع.

آثار التلوث البيئي متعددة تتراكم لتظهر كمشكلة مزمنة بعد عدة سنوات. تتسبب في انهيار الموارد الطبيعية كثرة المياه الجوفية و السطحية وتقلبات البيئة بسبب تراكم المواد الكيميائية و النفايات التي تغطي سطح التربة و تؤدي لفقدان الغطاء النباتي، حماية اقل فائض إنتاجية بعض المحاصيل مثل (ابوسعين)، وتوقف و انحسار مزارع دواجن عديدة بالحركة. كما تسبب في تلوث الهواء الأمر الذي أدى إلى إصابة معظم السكان بالمنطقة بأمراض الجهاز التنفسي، و تدهور الموارد البشرية و بالتالي خفض القوى العاملة و الدخل.

النتائج أظهرت أن النفايات و طرق معالجتها يجب أن تولى اهتماماً أوسع لتفادي الأضرار المستقبلية التي يمكن أن
تتفقّم وأخيراً خلصت الدراسة إلى عدد من التوصيات أهمها: العمل على تطوير جمع النفايات وطرق معالجتها.
Abstract

This study has been conducted to elaborate the environmental and socio-economic impacts that result from industrial hazardous waste due to miss management of dumping sites. Khartoum North Industrial Area was chosen as a study area and follows its waste from the resource generator up to the dumping site. The study followed many ways of collecting data and information as personal meetings reports and so on, but the main method was a questionnaire for a sample consisting of 60 persons of the population selected randomly.

The aim of the study is to assess the impact of industrial waste on the environment which results in series of harmful problems such as decrease of crop production in the area e.g. (abu sabeen) and degradation of poultry production.

The negative impact of any environmental pollution accumulates and appears as a serious problem after many years if not properly managed, causing natural resources degradation such as surface and ground water pollution, soil degradation due to accumulation of chemicals as (zinc and manganese) and waste on soil surface and loss of vegetation cover. Also it leads to air pollution which increases the respiratory diseases in the area.
Consequently, it results on human health deterioration and decrease in income. The results show that more attention should be given to the waste management in order to avoid the future problems and to achieve sustainable development. Lastly, the most important recommendation of the study: is to put more emphasis on proper waste management.
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Chapter One
Introduction

1.1 Industry in Sudan:
Permanent Commission To Combat Industrial Pollution indicated that industries were established in Sudan to meet the main needs of local markets for consumptive goods as oils, soap, and sweets. During the independance years other industries were established as cement and building materials, etc. (Sudanese Society for Environmental Protection, 1995).
Khartoum North industrial area is one of the most important industrial areas in the country, and it is surrounded with residential areas, which exposed people in these areas to degraded and unhealthy environment. The waste from the area varied between solid, liquid, and gas according to different kinds of industries. Disposal of these wastes is a big problem affecting the area and its surroundings for long time. Dumping of these waste was done randomly in neighbouring areas, which damaged natural resources.
There are many signs for environmental degradation, soil pollution, health problems, which indicate a dangerous situation. Waste extends to the near farms resulting in disappearance of soil surface and consequently of the depletion of removal vegetation cover.
Most of the owners of manufacturing factories in the area tend to maximize their profits through decreasing production costs. They don’t pay for waste treatments and manage it as it is in the environment that is creating a problem for the soil exposing it to erosion, water contamination and health hazards. (Babkir, 1998).

In 1962 industry in Sudan increased and more investments on this sector was made. From 103 industrial schemes established in the country 43 were in Khartoum Northern area. In 1962-1964 four factories from every 10 were in the area (ministry of commerce and industry 1996).

It was observed that the continued urbanization process in Khartoum has resulted in increased establishment of factories in Khartoum North. Some of the many factories responsible for such change could be related to the establishment of Khartoum North as an industrial center. This was supported by the presence of the railway and good transportation system for shipment of raw materials into and the produced goods out of the industrial area.

Moreover, the flow of the migrants from other areas in Sudan, and the supply of energy made the industrial area in Khartoum North more appealing.

Sudanese industries are still under developed and do not contain heavy machinery or nuclear technology. In spite of this, the secondary waste is one of the important environmental concern in Sudan because it is centered in
the most populated areas. (Ministry Of Environment And Tourism, 1996).

Major socio-economic development plans have been prepared during the post independance period including Sudan Ten Years Plan (1961-1971) which was concerned about agriculture modernization, the Five Year Plan (1970–1975) dealt with provision of water to enhance rural life, the Six Year Plan (1977-1983) in which the issues were the natural resources and environmental protection (KNM, 2004).

Comparing with developed countries, Industrial pollution in developing countries may not be as a severe problem, in Sudan the scale of industry is small, even though Deterioration will increase rapidly with expansion of the industrial sector without integrating environmental protection at all levels of development.

In 1986, a national economic conference was held and emphasized the importance of incorporating the environmental dimension in its economic development plans and policies. (Ministry Of Industry, 2001)

In 1991, the Higher Council for Environment and Natural Resources was established as the highest national authority to take care of the implementation of rules and policies of environmental strategies.

In 1992, the United Nations Conference on Environment and Development (UNCED) held in Rio de janeiro urged
Sudan to sustainable development and integrate it within socio-economic development strategies. Sudan has signed the World Convention and started to put emphasis on agro-industries and created a programme according to UNIDO services modules. One of its contents is industrial pollution control and waste management to promote environmental protection and sustainable industrial development through pollution prevention and industrial waste management. (Ministry of Industry, 2001)

1.2 Environmental problems:
Khartoum faced different problems due to poor waste management; these problems can be summarized in the following:
Environmental Health: environmental health has been observed in the prevalence of some environment associated disease such as Malaria.
Distribution of functional areas: Khartoum suffers from inadequate distribution of workplaces in relation to residential areas; also Khartoum suffers from the haphazard distribution of social services (such as schools, recreation centers etc).
Industrial areas: The growth of industrial areas in the centers of Khartoum north, and Omdurman is another factor that increases the landuse problem and the environment pollution reflected in air pollution due to oil
burring in the power stations at Burri and Khartoum north as well as from traffic.
Expansion of the residential areas: In the last two decades the urban boundary of Khartoum has been undefined and dynamic. More agricultural land is being lost to residential land. Agricultural landuse is under a heavy pressure from residential expansion and large areas of agricultural land are being transferred by residential blocks (Ali, 1999).
Waste water sewage disposal: Many parts of Khartoum do not have a sewage system through which waste water and human wastes may be safely and hygienically disposed of. Musa and Bridges cited in Abu Sin, 1991, that, “much of water waste sewage could be safely and sensibly used to water plants to beautify gardens and to grow vegetables; the high evaporation rates ensuring rapid circulation through the plants and into the atmosphere”. In 1962 Khartoum Green Belt was constructed. The western section of the Green Belt was irrigated by final effluents from Elqoz sewage treatment plant. Unfortunately, Elqoz sewage treatment plant stopped and the green Belt is considered as one of the major sites for insects breeding especially malarial mosquitoes.
Refuse disposal: The efforts for refuse disposal are very little especially when compared with the expansion of Khartoum city and the rapid growth of population. Some of these refusals are not disposed and constitute insects breeding sites, especially the housefly, and some of these
refuse disposal areas when burned increased the problem of air pollution.

1.3. Problem of the study:

environmental problem comes in line with Rio conference which concern in environmental degradation, particularly pollution effect called for precautionary measures as stated in principle (15).

1. Agricultural lands subjected to degradation through dumping of industrial waste. Land is non-renewable resource, could be lost due to dumping of no bio-degradable pollutant such as glass, plastic or inert.

2. Human and animal lives are threatened by emitted pollution of dumped waste.

3. Expected expansion over the affected area at present and in the future.

4. Pollution could lead to desertification. So one of the desertification definitions said:

(Desertification defined as a process leading to reduce biological productivity with consequent reduction in plant biomass, in the land’s carrying capacity for livestock, in crop yields and human well being leading to the intensification or extention of desert condition.

(UN conference on desertification, 1977)

From this definition any type of pollution affecting human and natural resources will lead in it’s last stage to a kind of desertification.

All the above results from mismanagement of industrial hazardous waste properly, mainly due to lack of
legislations, enforcement of proper pollution dumping and seldom use of environmental impact assessment (EIA) by factories which might have help in reducing negative impacts of pollutant in the area.

EIA is the assessment, evaluation, monitoring and forecasting of environmental impacts resulted from human activities. However, EIA has constaints in developing countries as follows:

1. Single industrial-decipline domination in project planning regardless recognizing impact of hazardous waste effects on other related activities and surrounding environment.
2. Lack of experince in conducting EIA anlysis in public and private sectors.
3. lack of awarness among affected target groups about environmental hazards.
4. lack of adequate infrastrucure to monitor baseline data for site – specific localities and regional planning and development.

Given these circumstances the study tackles how to manage industrial waste to reduce its impact on the environment and natural resources and human resources of the affected area.

1.4 Objectives of the study:

1. to assess the socio-economic status of the people of Khartoum north industrial area.
2. To assess the impact and management of industrial waste on crop production in the study area.
3. To assess the impact and management of industrial waste on poultry production in the area.
4. To assess the impact and management of industrial waste on pasture capacity in the area.
5. To assess the impact and management of industrial waste on human health.

1.5 Hypotheses:
1. There is land degradation due to mismanagement of waste dumping.
2. The deterioration of human health especially respiratory diseases is a result of neiboughoring the incomplete waste dumpign sites or waste generating sites to the residential areas.
Chapter Two
Literature Review

2.1 Introduction:
The environment can be defined as follows:

In General, “the environment consists of the substances, circumstances, objects, or conditions in the surrounding that can have either a positive or a negative effect on human and animal life. Environment can also be defined as a complex of external factors that act on a system and determines its course and form of existence”.

Socially: the environment is the culture that an individual life or education, and the people and institutions with whom he interacts.

Politically: “the environment is the natural world as perceived by humans, with particular reference to the damage done by human kind, or impact of this damage on human beings”. (www.free-definition.com)

Biologically: the environment is defined as the complex of climatic, social, and edaphic factors that act upon organisms and determines their form and survival.

Therefore, it includes everything that may directly affect the metabolism or behavior of a living organism including air, water, soil, and other living organisms.

But the question is whether the definition of the environment be related to man or not? There could be two answers: one is the classical opinion which considers the environment as an ecosystem in equilibrium and that
moves towards stability and nature can make itself in a balance. It is made to serve human needs.

“man is both creature and moulder of his environment,
which gives him the opportunity for intellectual,
moral, social and spiritual growth” (preamble of the United Nation Declaration On The Human And Environment.1992)

The other answer is a temporary one, which was stated in Stockholm International Conference, 1972, as :

“man has right to sound, clean, safe environment so he can live in dignity without regarding other organisms rights. But there is no absolute right, and every right is restricted by duties, man action should not be deteriorating to enviroment (Kanoan,1999).

**Economically:** To understand the relation between nature and economical resources we have to define the later. According to Recharl Leftwich *(undefined year)* “economical resource” is every resource that can produce goods to satisfy human needs. Also it is usually restricted to a value and cost. i.e. there is nothing free. The cost or the value of any economical resource changes due to scarcity. For example , fresh water, which is suitable for human consumption was easy and free but now water pollution makes it difficult and raises the cost, because water is transferred from one place to another and needs treatment to be suitable for use.
2.2 Pollution

Not every one defines pollution in the same way so there are different opinions about it. It began when human populations became so concentrated that their waste materials could not be absorbed by the environment as fast as it is generated. (EPA, 2004)

**Pollution** is release of harmful environmental contaminants resulting from technological development and increase in population density. Generally, the process needs to result from human activity to be regarded as pollution. Even relatively gentle human activity products are liable to be regarded as pollution, if they precipitate negative effects later on. It is anything produced by humans in a quantity that interferes with the health or well being of an organism. Pollution can take two major forms, local pollution and global pollution.

Early forms of pollution were largely organic materials, which can be broken down by decay organisms. Synthetics create a special problem because they cannot be broken by decaying and accumulate in the environment and tend to be persistent pollutants, which have chemically stable characteristics. In the past, only local pollution was thought to be a problem however, in recent decades, awareness has been rising that some forms of pollution causing global problems have been known. For example, human activity raise the levels of ground radiation all over the world, which may lead to
human health problems. Awareness of both kinds of pollution, among other things, has led to the environmentalism movement which seeks to limit the human impact on the environment. Serious pollution sources include chemicals, oil refinaries, toxic substances (which are illegally dumped), incinerators and animal waste. Some sources of pollution as oil tankers can release very severe pollution when accidents occur (www.free-definition.com). Pollutants are thought to play a part in a variety of maladies, including: cancer, immune diseases, and asthma.

### 2.2.1 Pollution from an economic point of view:

Previously, the concern about environmental pollution was totally of medical concern that deals just with its effects on human health. But later as the need to use the resource extensively the concern was pushed towards the quantity and economical evaluation of the resources and all risks related to environmental pollution such as inserting waste disposal costs. Any economic scheme, more or less, will affect the environment creating a social cost. Because if the polluter doesn’t pay for the pollution he made, another person will pay it indirectly. This will affect income and wealth distribution in the society (Alier, 1987).

In the following there are three main ways to control pollution:
Technical ways such as filters and other mechanisms to reduce the pollution.

- Policies and legislation: through obligation.
- Economical ways: which include:
  1. Optimum level of pollution.
  2. Polluter pays principles.
  3. Taxes.
  4. Subsidies. Support those who reduce their polluting activities.

It is an economic problem, which must be understood in economic terms. Of course, there are non-direct economic aspects of pollution, as there are with all economic problems, but all too often, such secondary matters. Market failures and spillover effects lead to inefficiency in the use of environmental resources. There is too much environmental pollution and insufficient environmental sound. Achieving economic profits can be made larger by controlling pollution as long as the marginal benefits of pollution control exceed the marginal costs.

In addition, economists are concerned with the way in which the damage by environmental pollution is distributed among different groups in the society, and the ways in which they might share the burdens of the costs of achieving pollution control. Specifically, economists concerned with two kinds of questions with respect to income distribution and environmental quality. The first is:
How are the damage of pollution distributed within the society? Is environmental pollution purely a middle- and upper class concern, as some have alleged? Or does pollution hit rich and poor alike? Who will reap the benefits of pollution control? The second set of questions concerns is who will bear the costs of pollution? (Coal, 1970).

2.2.2 Definitions of pollution prevention

Pollution prevention means "source reduction," as defined under the Pollution Prevention Act, and other practices that reduce or eliminate the creation of pollutants through:

- Increased efficiency in the use of raw materials, energy, water, or other resources.
- Protection of natural resources by conservation.

The Pollution Prevention Act defines "source reduction" to mean any practice which:

- Reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment.
- Reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants. (U.S.A. congress 1990).
2.2.3 Minimizing the cost of reducing pollution:
The rise of pollution and waste is not stable. Water and air pollution usually increase in the early stages of economic development, but once a certain income threshold has passed, people tend to value environmental quality more highly and have the resources to pay for protection measures.
The problem is that everyone in an area has to consume the same amount of environmental quality while the value of that quality and the price paid for it vary from one person to another. Some will want less than the efficient amount of pollution; some will want more; and almost no one will want the same amount (Lee, University of Georgia) (undefined year).
The efficient amount is what everyone would want if there was no cost to negotiate and each individual faced payments that honestly reflected the value he receives from pollution reduction.

2.2.4 Precaution:
The proclamation of the precautionary principle can be considered as one of the most important innovations of the Rio Declaration:

“In order to protect the environment, the precautionary principle shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific
certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation”. (UNCED 1992).

The precautionary principle is formulated to avoid environmental harm. Decision makers must adopt measures based upon a general knowledge of the environment and the problem its protection raises. As in all environmental issues the public must support the decision. The role of scientists includes then not only information given to the decision makers on a particular problem, but also general environmental education of the public and those who take the formal decision (Kanoan 1999).

2.2.5 The polluter pays principle:

It obligates the polluter who creates an environmental harm to pay compensation and the costs to remedy the harm. This principle is a very effective way followed by public authorities and countries in respective to encourage rational use of scarce environmental resources (UNCED, 1992).

Pressure on industry to reduce wastage comes from both internal and external economic drivers. Producer responsibility initiatives – already in place or proposed for a range of goods from batteries and packaging to vehicles and electronic equipment – make industry responsible for its products after use, and should result in fewer harmful
components, as well as, design decisions which will make disassembly and recycling easier.

2.2.6 National pollution prevention policy

Under Section 6602 (b) of the Pollution Prevention Act of 1990, U.S. A Congress established a national policy that:

- Pollution should be prevented or reduced at the source whenever feasible.
- Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible.
- Disposal or other release into the environment should be conducted in an environmentally safe manner.

Certain waste is excluded from regulation as hazardous waste even though it may potentially harm human health or the environment. Such as:

1. Domestic sewage.
2. Irrigation waters or industrial discharges permitted under Clean Water Act, so long as they are not stored on-site.
3. Certain nuclear materials as defined by the Atomic Energy Act.
4. Waste from the exploration and development of petroleum, gas and geothermal energy (waste from the
refining process may be classified as hazardous).

5. Household hazardous waste.

6. Agricultural waste, except some pesticides.

2.3 International Law and Policy

The United Nations Conference on Environment and Development (UNCED) held at Rio in 1992 focused international attention on the adoption of global policies whose explicit purpose was to reconcile economic development with environmental protection. In the Rio Declaration on Environment and Development, and in a programme of action known as Agenda 21, the Conference endorsed principles and policies with important implications for the future development of international and national environmental law. These included the notions that development must be sustainable, that the polluter should bear the cost of pollution, that individuals should have access to effective redress, that environmental measures should not arbitrarily or unjustifiably restrict international trade, and that environmental measures addressing transboundary or global environmental problems should as far as possible be based on an international consensus. The Rio Conference had a very wide-ranging mandate. One of its most important objectives was: To promote the further development of international environmental law, taking
into account the Declaration of the UN Conference on the Human Environment, as well as the special needs and concerns of developing countries, and to examine in this context the possibility of elaborating general rights and obligations of states, as appropriate, in the field of the environment, and taking into account relevant existing legal instruments.

2.4 Economic growth and environmental concern in developing countries:
During the last decade, a number of developing countries have begun to consider ways of developing and implementing programs to ensure the proper disposal of hazardous waste. To some extent, they looked for guidance to the experience of the many developed countries that have established effective hazardous waste management programs during the last 30 years. Building an effective hazardous waste management system is difficult and lengthy. The method followed in one country may not work in another. Fundamentally, the goal of a hazardous waste management program is to change the behavior of those who generate hazardous wastes so that they routinely store, transport, treat, and dispose of them in an environmentally safe manner. In many cases, the waste of natural resources practices typically stem from faulty government policies, but the
question is why governments adopt or maintain these weak policies? (Freeman, 2003).

2.5 Waste:
During the last twenty years the world has experienced an explosion of environmental regulations. Much of that has dealt with the way in which businesses and individuals produce excess and unwanted materials. And the common terms are “waste generation” and “waste management”. Waste is an inevitable by-product of most human activities. People have been generating and discarding materials since hunter-gatherers threw bones and vegetable remains outside their caves. There is a tenet towards a recent definition of the term waste which said that “waste is any object whose owner does not wish to take responsibility for”. This definition provides a real condition of objects and it’s possibility of discard resulting in pollution and contamination, also provides a framework to minimize or eliminate the waste. (Maclaren, 2003)

For many hundreds of years those wastes consisted exclusively of matter which biodegraded easily (such as vegetable and human wastes), or were inert (such as bones and wood ash). Given the relatively small population, the quantities of waste were minor and could be readily absorbed by the environment; indeed they had value in fertilizing the soil.
As the global population grew, and urban and industrial development accelerated, the opportunities to dispose of materials, including biodegradable ones, diminished while the quantities and value of wastes increased. Society now has large volumes of waste to deal with.

2.5.1 Care about preventing waste

Population, consumption and technology impact the environment in way of two major types of human activity. First, using resources, then occupy or prevent the use of space, and so modify or remove entirely the habitats of many wild species. Also extracting resources growing food, catching fish, mining minerals, pumping groundwater or oil. This affects the stock of resources available for humans and for other species in the future.

Second, dumping wastes – not just those that consumers throw away, but all the waste solids, liquids and gases that are generated from raw material to final product. These affect the state of land, groundwater, rivers, oceans, atmosphere and climate.

Every business generates waste. For some, it may be only waste paper or dirty water; for others, it may be hazardous or toxic wastes that require special handling and disposal. Whatever the type or volume of waste the company generates, it is all the same in one respect, it is costing it money. In fact, they’re paying for it twice. Once when they buy it and the second time when they throw it
away. The bottom line is that preventing waste will save money.

Waste prevention is the right thing to do in addition to financial advantages. Preventing waste prevents pollution, making neighborhood and community a safer, healthier place to live. In the end, people benefit, the environment benefits, the community benefits, and the company establishes itself as a good corporate citizen, providing immeasurable, lasting rewards.

Laws to raise waste management standards were first introduced at the beginning of the 20th century, and today there is a flood of such regulations. As well as protecting public health and reducing local nuisance, these laws are increasingly aimed at protecting the wider global environment. Waste is no longer a local issue. There are global concerns about the consumption of finite resources and the impacts of their acquisition, as well as the effects of waste management and the transboundary nature of pollution (EPA, 1988).

2.5.2 Waste and natural resources:

Resources have traditionally been the main focus of concern about the impact of population and consumption on the environment. Frequent warnings were issued that we faced massive famines, or that we would “run out” of essential fuels and minerals. More recently, it has become
apparent that more serious, more immediate and more intractable problems lie in the global threats that derive from our wastes.

Resources fall into two main categories. Renewable resources like water or fish are replenished naturally. Non-renewable resources like oil or iron ore have a limited stock that is not replenished, except on geological timescales of millions of years.

By definition, renewable resources are replenishable by nature yet replenishment is not guaranteed. Renewal occurs only if they are given the chance to renew. If we exploit them faster than they can renew themselves, they deplete or degrade. The majority of renewable resources, including the most basic ones needed for human survival – land, food and water – are now affected by human overexploitation or pollution. (EPA,2004).

Ultimately, all non-renewable resources on Earth are limited: if used constantly they must sooner or later run out. So far, however, the threatened exhaustion of non-renewable resources has not happened.

Humans raised the level of CO₂ in the air from 280 parts per million in pre-industrial times to 363 parts per million in 1996. Over this same period methane concentrations raised by 145 percent. There were no gaseous chlorines in the atmosphere before industrial times. By 1996 there were 2731 parts per trillion, most of these produced in the 20th century (EPA,2004).
Significant traces of organic and metallic pollutants are now found in the deepest marine sediments, in the remotest glaciers and icecaps, and in the fat of arctic mammals. Studies of human breast milk have found traces of more than 350 contaminants, including 87 dioxin and dioxin-like compounds and 190 volatile compounds. (Tay, 2003).

2.5.3 Industrial waste:
Since the industrial revolution, industrial and mining operations have been accompanied by a problem: industrial waste which may be toxic, ignitable, corrosive or reactive. If improperly managed, this waste can pose dangerous health and environmental consequences. It is generated at every stage in the production process, use and disposal of manufactured products. Thus, the introduction of many new products for the home and office - computers, drugs, textiles, paints and dyes, plastics - also introduced hazardous waste, including toxic chemicals, into the environment. These, too, must be managed with extreme care to avoid adverse environmental or human health impacts (Maclaren, 2003).

2.5.3.1 General waste classification:

It is classified into solid, gases and liquid as follows:

2.5.3.1.1 Solid waste:

Generally, there are about 43 industrial solid waste divided into 5 major classifications:

1. Drugs and food.
2. Apparel includes clothes, leather loundary trade.
5. Energy (coal processing, steam power, nuclear).

2.5.3.1.2 Industrial gas waste:
Includes both organic and inorganic compounds in the form of particulate vapour and powder such as carbon, nitrogen sulphur, and lead.
Sources:
All metal industries, fertilizers, medicine, plastic (which is not decaying material).

2.5.3.1.3 Industrial liquid waste: (sewage)
Sewage may be of domestic, commercial industrial or agricultural origin or a combination of all.
The sewage usually contains some of the following:
1. Organic and inorganic compounds.
Organic materials need more dissolved oxygen (Nolan, 2002)
Inorganic materials usually degrade slowly and cause blockage.
2. Toxic compounds, which may accumulate and cause drastic chemical effects.
3. Suspended solids: usually contain a complex range of solids, some in solution and some in suspension and this gives rise to turbidity and indicates the presence of various chemicals and micorbiological pollutants.
5. Oils.

2.5.4 Waste categories

Waste can be categorized into controlled and non-controlled waste. (FIG.1) The controlled waste include among others hazardous and non-hazardous waste as explained below:

Figure(1): The waste classification system.
2.5.4.1 HAZARDOUS WASTE

A solid waste is hazardous if:

A. it is listed in one of three categories:
   - Source-specific waste. This list includes waste from specific industries such as petroleum refining, wood preserving and secondary lead smelting, as well as sludges and production processes from these industries.
   - Generic waste. This list identifies waste from common manufacturing and industrial processes including spent solvents, degreasing operations, leachate from landfills and ink formulation waste.
   - Commercial chemical products. This list includes some pesticides, and other commercial chemicals.

or

B. If it is characterized, with:
   - Ignitability.
     Ignite substances are those which burn easily and thus cause fire hazards.
   - Corrosivity.
     It is a characteristic of substances, including all acids and alkalis that have the ability to corrode or decay materials.
• Reactivity.
Reactive substances are unstable and tend to shock, heat and react with acids or water.

• Toxicity.
Toxic substances are those which cause direct toxic effects to humans and animals lead to toxic accumulation in the environment or/and food chain.

2.5.4.2 NON-HAZARDOUS INDUSTRIAL WASTE
Non-hazardous industrial waste are those that do not meet definition of hazardous waste - and are not municipal waste.

Table(1)

<table>
<thead>
<tr>
<th>EXAMPLES of hazardous waste generated by industries and businesses:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Waste generator</strong></td>
</tr>
<tr>
<td>Chemical manufacturers</td>
</tr>
<tr>
<td>Industry</td>
</tr>
<tr>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Printing industry</td>
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<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Petroleum refining industry</td>
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<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Leather products manufacturing</td>
</tr>
<tr>
<td>Paper industry</td>
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<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Construction industry</td>
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<tr>
<td></td>
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<tr>
<td>Metal manufacturing</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>


2.5.5 Impacts on environment:
• Decomposition of organic waste is a major source of escaping gases which contributes to global warming

• Even with controlled landfilling, only 45% methane can be utilized, the rest escapes to the atmosphere, together with other harmful gases

• Global warming potential of methane is significantly higher than CO₂

• Leachate from decaying organic waste. Threatens future water supplies.

2.5.6 Waste management:
The methods in use over the world:
A. Chemical treatment:
It is usually before disposal through detoxification, there are many methods of detoxification but all are expensive.
It includes:
1. Neutralization: common detoxification process by adding lime to acidic waste to prevent the precipitation of heavy metals from hazardous waste generated from iron and steel industries.
2. Oxidation reduction reaction: it is used to remove organic materials from the waste and it is used in textile industries to remove the dyes form liquid waste.
B. Biological treatment:
Includes composting of organic materials. Disposal of heavy metals and non biodegradable waste. these should be prevented to avoid their accumulation in the soil or not to be carried by runoff water or leaching.
C. Incineration:
It may some times result in hazardous residuals. It should be done under controlled conditions:
   1. High burning efficiencies are required to ensure complete destruction.
   2. Use air pollution traps equipments such as fillters.
D. Land fill:
Must be under controlled conditions and greater precautional measures should be taken and that is by:
   1. Prevent leaching.
   2. Separate incompatible( non similar) waste.
   3. Check migration of the waste from the trench.
   4. Knowing exactly about the information of subsurface geolgy and water movments.
   5. Several barriers are to be used to ensure that the waste will be well stored.
   6. A leachate collection system must be constructed to collect any waste that may infiltrate (Eckman,1997)

2.5.7 Consequences of untreated waste
Serious problems may be generated from untreated or unmanaged waste. It can cause environmental and health hazards resulting from uncontrolled escape of gases, e.g. methane or from contaminated water or soil. Also it leads to raise the cost of land fills and construction of dumping sites and need for large size of land. In addition to this the risk of explosions and fire is possible.

2.6 Developing nations:
In developing nations waste is a resource, but the issue is only who has the access to that resource?. In Cairo for example, an entire recycling industry grew up with the poorer people in the community collecting trash and using it to feed an expanding network of workshops using paper, rags, plastic, and glass waste. This was providing employment and incomes for the minimum wage prevailing in Egypt. (www.UNDP.org 2004).

The main environmental problems in Sudan are:
- Desertification and land degradation.
- Deforestation.
- Wildlife depletion.
- Use of agrochemicals.
- Diseases related to water provision for irrigation (water borne diseases).
- Uncontrolled urbanization.
• Marine and costal pollution.
• Industrial pollution.

(Ministry of industry Sudan, 2001)

2.7 Applying cleaner production process and techniques:
Major constraints in adopting cleaner production methods in Sudan relate to:

• Lack of awerness about the environmental and financial benefits of cleaner production activity.
• Lack of information about technologies that can reduce pollution.
• Inadequate financial resources.

2.8 How is waste managed now?
Hazardous and non-hazardous wastes have been ‘co-disposed’ into landfill (i.e. put in the same hole in the ground). This mixing of waste could cause long term damage to the environment and also has the potential for different types of waste to react with each other.

2.8.1 Production:
Hazardous waste is produced in many ways. It might come from demolition work (producing materials such as asbestos or contaminated soils), manufacturing processes (oils or chemicals) or the disposal of consumable goods (such as used fluorescent light tubes or computer monitors).

It all requires correct disposal. Waste producers have a legal duty of care to dispose of their waste, so they need
to ensure they employing properly licensed waste carriers to collect it.

2.8.2 Disposal
The waste carrier is to take waste to an appropriate waste disposal site. The most common types are landfills, but other methods include re-cycling plants, incinirators (burning) and composting. Site operators have to manage their site according to the regulations under the landfill directive and other waste regulation so must refuse to accept wastes for which they are not licensed (www.pollution.com, 2004).

2.8.3 Landfill Site
It is an area of land where garbage is taken, buried and covered daily; using environmentally sound methods, unlike old fashioned dumps.

2.8.3.1 Impact of disposing waste to landfill:

• **Pollution of land, air and water resources.**
  Poor waste management practices can lead to the pollution of surface and groundwater resources, air pollution, the generation of greenhouse gases (methane is a major greenhouse gas that is released by landfill sites), site contamination and the generation of odours.

• **Harm associated with hazardous waste.**
  The improper disposal of hazardous waste to
landfill, stormwater drains, surface and underground water resources can harm the environment and potentially cause injury or harm to humans and other organisms.

- **Impact on communities.** Effects on communities associated with the disposal of solid waste to landfill include reduced property values adjacent to landfill sites, the risk of fire, and pests associated with birds, dust, odours and pests (Barry, 1999).

### 2.9 Eco-efficiency

It is a relatively new term for businesses, which are more likely to be familiar with the concepts of waste minimization, cleaner production and pollution prevention. Eco-efficiency is strongly supported by the business community because it does not focus exclusively on environmental outcomes. Rather, it recognizes the benefit of combining environmental and economic objectives.

With the growing focus on eco-efficiency, the belief that economic objectives and environmental concerns are in conflict is being challenged. Eco-efficiency means producing goods and services with less energy and fewer raw materials, resulting in less waste, pollution and cost (Connor et al. 1999).

A growing economy and population create a rising demand for goods and services provided by businesses, industries and governments. The main
drivers of waste generation in South Australia for example, are economic growth, urban consolidation, household formation trends (fewer people in more dwellings), under-provision of garden waste and other recycling services, and community attitudes. The consumption patterns tend to be linear: people consume natural resources to make products or provide services and waste is generated as an end result. Waste is material discarded, used up or left over in the course of industrial, commercial, domestic or other activities.

The majority of the solid waste (waste that is not hazardous or in liquid form) is sent to landfill depots for disposal – an expensive and traditional approach. The rate at which humans are sending waste to landfill is increasing. Hazardous wastes, including radioactive wastes, which pose a risk to human health and the environment, require special handling and disposal. The rate at which they are producing these wastes is also increasing. If improperly managed waste can pollute the land, air and water.

people need to minimise the waste that generate and recycle as much as possible. Community participation in recycling is increasing as a result of the recycling services (connie et. al.,1999).
Chapter Three
The Conceptual Framework and the Methodology

3.1. The conceptual framework
From figure (2) we introduce four major factors that have direct effects on the environment. These are land, water, atmosphere and man. These factors interact with each other and result in deterioration or replenishment of the surrounding resource base. One of the off-shoots of these four factors interaction is represented by hazardous waste. Hazardous waste is among the recent reported factors that do harm to the environment.

3.1.1. Effects of hazardous waste on land:
The hazardous waste could have several negative effects on land in which it is dumped. Few of these effects are cited below:

- Loss of agricultural lands: Dumping of waste that includes chemicals and hard solid objects may result in changing the chemical composition of soil and physical structure of land available for crop production. Such changes may result in poor soil capacity to produce crops and hence result in either low crop productivity or inability of crops to grow at all on these polluted lands. The land will thus out of production.
- Loss of rangelands: creeping of waste covers the natural vegetation and removes it.
• Loss of top soil surface: waste may break soil particles and change soil texture which leads to erosion.
• Decrease in land productivity: crop production will decrease due to burial of fields under waste or due to destruction of marginal farms by heavy machines.
• Blockage of irrigation channels: results from dust and waste or passing of vehicles.

3.1.2. Effects of hazardous waste on water:
Either by direct dumping of waste on water bodies or by leaching of waste into ground water causes water contamination or pollution by chemical toxic substances. This polluted water would result in infection of people and animals with diseases or may lead to their death.

3.1.3. Effects of hazardous waste on air:
• Gases from industrial activities cause air pollution.
• Gases form dumping site: Releasing of these gases plays a role in earth heating and increase carbon dioxide and other toxic gasses in the atmosphere.
All these factors have negative effects on the health of humans and animals and would lead to poor communities with low income and degraded environment. This situation could create a vicious circle with an endless loop unless broken by an appropriate waste management. Improving the knowledge and extending awareness of clean environment and industrial processing production is a
pre-requisite that is needed to be addressed. This study work attempts to address such a crucial issue conceptually and empirically.
FIG. (2): conceptual framework for hazardous waste effect on environment

- Waste
  - Environmental degradation
    - Agricultural lands
      - Lost of soil fertility
      - Log pf irrigation channels
    - Land degradation
      - Low crop production
    - Low ranges production
      - Low animal production
        - Death of animals
        - Low income
          - Poor society
    - Low income
  - Human resources
    - Diseases
      - Death
      - Remedies cost
    - Low productivity
3.2 The study area
The study area falls within the premises of Khartoum North, being one of the main cities which forms the capital of the country. It was established with the railway building, which made it a commercial center for exporting and importing goods. This attracted people and labourers from all over the country and in 1969 about three quarters of the factories were centered in the capital. About 63% of these factories was placed in Kahrtoum North area (babkir, 1998).

3.2.1 Location:
Kahrtoum North lies between 10° – 15° North latitude and 16°- 30° North longitude.

3.2.2 Topography:
It is semi plain area with accelerated urbanization and having a swift transportation system.

3.2.3 Soil:
Clay, muddy soils, brownish grey with percentage of gypsum in its lower layers (Ali, 1999).

3.2.4 Information gathered from local office state:
Khartoum North industrial area includes 548 factories as follows:

**Table (2)**

<table>
<thead>
<tr>
<th>Type of industry</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Food industries</td>
<td>183</td>
</tr>
<tr>
<td>2 Chemicals</td>
<td>158</td>
</tr>
<tr>
<td>3 Textiles</td>
<td>57</td>
</tr>
<tr>
<td>4 Metalic industries</td>
<td>25</td>
</tr>
<tr>
<td>5 Equipment</td>
<td>32</td>
</tr>
<tr>
<td>6 Mines</td>
<td>50</td>
</tr>
<tr>
<td>7 Papers</td>
<td>30</td>
</tr>
<tr>
<td>8 Wood and irons</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>548</strong></td>
</tr>
</tbody>
</table>

*Source: Bahry local municipality, 2004*

### 3.2.4.1 Land fill sites

**Elselait**: is the first land fill area and it neighbours Elselait agricultural scheme and rangelands.

**Elkadro**: is the second landfill area and is composed of about 2 X 3 kilometers in area and about 10 meters deep.

### 3.3. Materials and methods

#### 3.3.1 Primary data:
The study depended on primary data and information to provide the material for analyses, interpretation and discussion to arrive to reliable conclusions and develop remedial recommendations that may help in correcting the negative aspects of hazardous waste. A structured questionnaire in addition to observations, photos of the study area, discussions with residents and labourers working in the study area were the main sources of data collection and supply of information. Extra data and information on effect of hazardous waste pollution on crop production, poultry production and pasture grazing was collected from sources in the study area.

At first, the author visited a number of factories in Khartoum industrial area including El Robi Batteries Factory and the Arabic Company for Oil and Soap. It was observed how these factories discard off their waste on natural resources such as fertile soils of El Selait crop production area. The researcher was able to identify and classify the different constituents of waste dumped composition of the chemical industry such as that of soap, batteries, and medicines’ factories.

Respondents from these factories indicated that they make a contract with the local governmental office by which the latter are obliged to pay for waste transportation and dumping by that office. Alternatively, these factories have the opportunity of dumping their
waste at their own cost through transporting their waste by themselves.

The field survey used the questionnaire by asking a sample of 60 individual respondents representing more than 5% of the total residential population of the study area. These respondents were selected randomly in their houses, markets and the place of work. The author also extended the respondents sample into the neighbouring farms asking farmers and seasonal labourers on these farms laying near or on the land fill sites of Al Seleit area and El Kadaro area.

The questions of the field survey focused on expected harm that might be caused by the dumping of hazardous waste on their health and their life. Examples of some of the questions are given below:

1. Is there any negative effect of waste on your health?
2. What is the effects of waste on your land and animal production? A copy of the field survey questionnaire is attached as an annex (1)

### 3.3.2 Secondary data:

Secondary data were obtained from web sites dealing with environmental issues, journals, reports from local office, which is responsible for waste collection in the area and the office responsible for giving licenses and supervision of the last stage in land fill site, and Sudanese Environment conservation Society.
3.3.3 Methods of analyses:
The author used a personal computer and EXCELL software package to perform the analyses.
Chapter Four
Results and Discussion

4.1. Introduction
It was observed that the factories dumped their waste in its way from the production site to the dumping site without any precaution or safety measures. This causes a series of problems. The ideal management is to have a clean product that goes through many operations before its disposal. For example the battery factories, generate waste, which contain manganese and zinc elements. The soap factories generate of chemicals that should be subjected to treatment in many septic tanks before they are discarded as clean harmless water. But this is not the rule, usually because these treatments are costly not all factories have the ability to do it.

4.2 General characteristics of the population
Waste dumping neighborhood:
Table 3 shows that about 22% of the respondents were employees, 58% were labourers and 20% were job-less. About 14% of the respondents were university graduates, and 40% had medium educational level, 22% had vocational education while 24% were illiterate. These characteristics indicate that the society of the respondents is composed of largely employed and of high and moderate level of education. That consists a considerable layer of the society have the right to live in dignity and safe environment.
Table 3: Social indicators of the resident of El Seleit neighbouring waste dumping sites, North Khartoum (in percentages).

<table>
<thead>
<tr>
<th>Age</th>
<th>Job</th>
<th>Educational level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>employees</td>
<td>labors</td>
</tr>
<tr>
<td>&lt;35</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>36-50</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>&gt;50</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>58</td>
</tr>
</tbody>
</table>

4.3 The institutional set up of the Dumping waste supervision and handling:

There is an office in Khartoum North (Bahry) market which is concerned with collecting fees and issues license to factories to discard off their waste. According to reports from this office the cost of dumping of waste was as follows:

1. The transportation of waste container: SD 7500 per day.
2. Land fill fees: SD 5000 per month.

Every loading vehicle of two yards³ size, has five labourers in addition to the driver and one observer. The observer has to be sure that hygenic procedures are followed when dumping the waste according to regulation. Legislations and by-laws are not strict enough to force the factories to transport their wastes on their own. Also the weakness of the supervision and monitoring from environmental-health authorities make the hamper proper
disposal of waste. For example, some food industries, which have to dispose expired goods can sell these goods to small traders instead of dumping them. The reported estimated amount of disposed waste per day amounts to approximately 424.728 tons (Kartoum North municipality, 2004).

It was found that the landfill area takes about 25-30 years after being closed before using again. During this period the problem would be whether a factory or a company would be ready to follow the legal measures of dumping waste in the landfill area or not?

4.4 The composition and the expected negative effects of hazardous dumped materials:
The local authority reports indicated that the different waste material could be classified as follows:

1. Industrial waste causing cancer, such as the waste of the asbestos factory which is still working near a residential area.

2. Toxic waste that contains heavy metals such as mercury, lead and zinc as in batteries, which may accumulate on the soil harming both crops and humans.

3. Industrial waste that cause air pollution.

4. Acids wastes as in textile and cleaning materials, which may be carried by run-off and cause soil sodicity or soil salinization, or it may contaminate
water and food causing irritation and ingestion diseases.

In particular, negative effects of zinc and manganese are given below:

1. **Zinc chloride**

   This is extremely destructive to tissue of the membranes and upper respiratory tract. It would be harmful and toxic to ingestion tissues.

   This chemical compound may cause severe irritation and skin burns and ulcerations. It may also cause pain and may damage the eyes if contacted.

2. **Manganese:**

   People living near a waste site could possibly eat or drink higher than usual levels of manganese that are in soil or water or breathe manganese-containing dust particles that come from waste site. This could have an adverse affect on the nervous system, and may result in changes in the brain and can cause irritation of the lungs making breathing difficult.

   Soils covered with burning chemical waste resulting from medicines factories and create a solid layer over the soil surface, either fragmenting soil particles or pollute it preventing vegetation recovery and lead to soil erosion. Also these ashes may be transported with surface runoff and thus contaminate surface water or they may be leached downwards into underground water and; thereby,
pose a threat upon food chain and human health. (Plate 1)

4.5 The effect of hazardous dumped waste on human health:

Table (4) shows the health status and place of work of the respondents. About 59% of the total respondents were not in good health. About 44% of sick respondents suffered from respiratory diseases, 11% had diseases related to stomach pains and 14% suffered from other diseases like skin irritation.

27% of the sick respondents were actually found to be ill before coming to the infected area. About 27% suffered from illness by the time they joined work or lived in the neighborhood of the waste dumping sites. The rest of the respondents did not know the exact date of getting the diseases. About 32% of the sick respondents were working in the industrial area, and 18% were working in other places. However, this last category lived near the waste dumping area. About 9% of the respondents, although not working in the industrial area, yet they live near the dumping sites.

Table 4: The health status of sick respondents

<table>
<thead>
<tr>
<th>age</th>
<th>Health status of sick respondents</th>
<th>Kind of diseases among sick respondents</th>
<th>Date of diseases stated by sick respondents</th>
<th>Place of work stated by sick respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Respiratory Ingest-ion others</td>
<td>Before After No date</td>
<td>Industrial area Other place Non</td>
<td></td>
</tr>
</tbody>
</table>
Table (5) indicates that family health status as they were expected to get diseases from polluted area around. About 52% of the total respondents indicated that they have one or more sick persons in the family. About 37% of the respondents mentioned that they are sick with respiratory diseases. The majority of those who have respiratory system affected were above 50 years old. About 6% had suffered from ingestion diseases, while those who suffered from other diseases were to about 9% of the sick respondents.

The results of the statistical analyses showed that about 27% of the sick respondents’ population became ill after they resided in the polluted area.

**Table 5**: The status of diseases among families of labourers and residents respondents in and neighbouring Khartoum North industrial area.

<table>
<thead>
<tr>
<th>age</th>
<th>Existing sick respondents families</th>
<th>Kind of diseases among sick people in the family</th>
<th>Date of diseases as stated by the sick people in the family</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>respiratory</td>
<td>Ingestion</td>
</tr>
<tr>
<td>&lt;35</td>
<td>27</td>
<td>15</td>
<td>3</td>
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<tr>
<td>36-50</td>
<td>15</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>&gt;50</td>
<td>17</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>59</td>
<td>44</td>
<td>11</td>
</tr>
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</table>
Table 6 shows that about 90% asserted that dumped waste have polluted their air and surroundings and had negative impacts on their health. Considering the cost of medical and clinical treatment, almost half of the respondents (about 52%) have paid high cost while about 32% were able to manage with their remedial cost.

Table 6: total respondents opinions on effects of health and cost of remedies.

<table>
<thead>
<tr>
<th>age</th>
<th>Effects on health*</th>
<th>Cost of remedies**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>&gt;35</td>
<td>43</td>
<td>2</td>
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<tr>
<td>36-50</td>
<td>27</td>
<td>3</td>
</tr>
<tr>
<td>&lt;50</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>10</td>
</tr>
</tbody>
</table>
*90% of the total respondents indicated the effects of health, while 10% did not respond to this question.
** This question was answered by the total number of respondents.

4.6 Effects of hazardous waste dumping on or nearby crop and animal production farms in El Seleit and El Kadaro areas.

The farms in land fill areas are exposed to:

1. Blocking of irrigation channels due to dust and plastic waste cover.
2. Destruction of vegetable farms due to passing of heavy vehicles that transport waste through narrow roads.
3. Loss of vegetation cover in the area as a result of waste creeping.
4. Destruction of the crops due to covering by waste.
5. Loss of top soil which eroded or was buried under waste.
6. Death of animals that graze near the area as a result of eating plastic materials.
7. Reduction of green patures’ carrying capacity due to exposure to hazardous waste over land in the area.
8. Death in poultry farms. Birds are more sensitive to heat and odor so the poultry farms near waste dumping site were totally destroyed.
9. Diseases and health hazards, specially respiratory diseases to those who are living near the site. The relation between respiratory diseases and the place of living is 30.5 % which is a significant result.

10. The economic loss of buildings and equipment of the farms.

Hills of plastic, glass and papers which are non-degradable materials cover the area, this may through time compact the soil and change its texture or it may cause hazards such as accidental fires or can move to nearer ranges and animals.

(Plates 2, 3)

Table (7) shows that 68% of the respondents have indicated that, the animal production activities established near the waste-dumping area were affected by waste pollution. About 55% of the respondents have indicated that, agricultural lands in this neighborhood also suffered and 48% of lands were left idle without production.

The affected agricultural land owners had suffered high cost on seeds lost to wasted land accounting to 33% of the crop producers in that area. About 58% reported to have been negatively affected at irrigation stage. About 28% had been affected during cleaning stage and 13% during harvesting stage.
Table 7: Impact of waste pollution upon crop and poultry farmers and grazing ares in the waste dumping places in percentages.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Effect</th>
<th>No respond</th>
</tr>
</thead>
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<tr>
<td>Effects on animal</td>
<td>68</td>
<td>32</td>
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<tr>
<td>Effects on agriculture</td>
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<td>45</td>
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<tr>
<td>Effects in land reduction</td>
<td>48</td>
<td>52</td>
</tr>
<tr>
<td>Effects on input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeds</td>
<td>33</td>
<td>67</td>
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<tr>
<td>Irrigation</td>
<td>58</td>
<td>42</td>
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<tr>
<td>Cleaning</td>
<td>28</td>
<td>72</td>
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<tr>
<td>Harvesting</td>
<td>13</td>
<td>67</td>
</tr>
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</table>

4.7 Assessments of farm production activity losses due to dumping of hazardous waste:

One of the farms that went out of production in El Kadaro area had estimated its financial loss as follows:

The total area of the farm was about seven feddans, part of which was cultivated with Abu Sabeen forage. The other part was used for raising poultry in an area extending over 900 square meters.

4.7.1 The crop production activity:

1. The cost of the Abu Sabeen crop production activity was about SD 30,000 per feddan, totaling about SD 0.21 million for the whole crop activity. This cost went into SD 0.63 million as the Abu Sabeen crop was cultivated three times a year.

2. The benefits of one feddan ranged between SD 20,000 and SD 60,000 according to the season. Thus the total benefit of the crop production would rise up
to a range of SD 0.42 million and SD 1.26 million during the whole year.

3. All these benefits were lost due to pollution of the crop land by dumping of the hazardous waste in this area. This financial loss would continue to expand as long as the dumping process continues on.

This is an area used to be cultivated by “Abu Sabeen’ which has now turned into bare soil and lost the benefits of its produce. This resulted from plastic waste that covered the crop preventing water and air form reaching the crop during its growing. (plate4)

4. 7.2 The Poultry production activity:
The area of poultry was divided into three parts. Each part contained about 1.500 chickens, totaling to about 4.500 chickens. This poultry farm was producing about 4.000 eggs per day with a total value of SD 66.600 per day.

The inputs for this poultry activity were composed of the following items and cost:

4. There were about 1570 drinking pots, which cost about SD 1.57 million,

5. There were about 1570 eating pots, which cost SD1.575 million.

6. There were several clay jars for laying eggs each had a cost of about SD 400. About 20 of these clay jars were used to accommodate 1000 laying hens.

7. The farm was covered with about 650 meters of plastic material for protection against heat.
8. The electricity and lights.
9. The pesticides machine and fodder milling machine.

(Plate 5): This Poultry farm was damaged and exposed to death due to bad smells and dust. It reflects the loss of farm equipment and loss of about 45.000 birds and its production.

(Plate 6): Describes side of the same farm covered by waste and became function less, reflecting the economic loss of constructions and other services.

(Plate 7): Reflecting bare land covered by waste with remaining dry branches my cause accidental fire. The farm can not be used unless the waste land fill site closed at a prohibitive cost.

(Plate 8): shows how the heaps of waste creeping towards the green areas, and reflect the narrow distance between the dumping side and vegetation areas.

(Plate 9): The photo shows the area not yet fully affected. These range and grazing animals are just about half kilometer far from dumping area, which would expose them as animal diseases or animal death.

(Plate 10): Shows the margin between range and dumping site which nearly degraded and vegetation is being depleted. Also the soil in these areas become contaminated and may transfer by wind to another places as carrying disease agents.
It was a naturally vegetated area. And it is clearly that the area is going towards desertification. Precautions and fast remedies must be done. (Plate 11) Dumping area near the farms resulting in vegetation cover loss. It is shown that there is trench for dumping waste but usually not all waste is buried as it should be, due to absence of monitoring and shortage machines like loaders and others... (Plate 12).

4.8 Environmental impact analyses using financial cost benefit analyses method:
This a hypothetical example assessing the expected damage and the cost to the private sector and the society due to effect of hazardous waste and degradation of the environment in EL-Selait and EL-Kadro areas. The analysis was based on realistic data and information collected from affected farmers in the study area. Annual budget was prepared indicating expected annual profit of a mixed fodder and poultry farm. Than the analyses assessed the financial feasibility for the farm under two scenarios:-

- Without pollution.
- With pollution.

Assumptions:-
- The life span for the farm equal 25 years.
- Prices taken at 2004 as a base year.
• No inflation effect during the life span of the project.
• Use 15% as a discount factor, which also indicates the cost of lending to this farm.
• Replacement of certain investment materials were undertaken after reaching salvage status.

The farm used seven feddans for producing Alfa-Alfa fodder crop and 900² meters for poultry raising 4.5 thousands laying hens giving about 4 thousands eggs per day.

Production period for laying eggs was about 300 eggs/year.

Result:-
1. Budget analyses for the farm without pollution (Table 2):-
Gross marginal revenue: 11195 SD.
Net profit: 9776.456 SD.
This shows that the farm activity was expected to be profitable without the effect of pollution.
2. Financial feasibility analyses results indicates that the pollution effect has expected negative impact on the profitability of the farm activity:-

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<th>indicator</th>
<th>Without pollution</th>
<th>With pollution</th>
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</thead>
<tbody>
<tr>
<td>B/C *</td>
<td>1.4</td>
<td>0.9</td>
</tr>
<tr>
<td>IRR **</td>
<td>31%</td>
<td>Very low</td>
</tr>
<tr>
<td>NPV ***</td>
<td>SD 31965 million</td>
<td>SD-13.078 million</td>
</tr>
</tbody>
</table>

Source: table (9) and (10)

*B/C: benefit cost ratio indicates the extent of revenue obtained by unit cost.
**IRR**: indicates the discount factor at which net present value is equal to zero. Any discount factor less than IRR indicates a positive NPV.

***NPV***: net present value which is present value of total revenues - total cost estimated at the given discount factor.
Budget analyses

Farm is composed of producing Abu Sabeen forage crop in an area of 7 feddans and producing around 4.5 thousand laying hens giving about 4 thousand eggs per day.

<table>
<thead>
<tr>
<th>Investment cost/year</th>
<th>SD (000)/fed</th>
<th>Area (fed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land rent for 25 years at SD2500/yr</td>
<td>625</td>
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<tr>
<td>Irrigation</td>
<td>300</td>
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</table>

<table>
<thead>
<tr>
<th>Poultry farm</th>
<th>SD000)/square meter</th>
<th>Quar</th>
</tr>
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<tr>
<td>Pen (900 square meters)</td>
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<td>Water supply equipments</td>
<td>4</td>
<td></td>
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<tr>
<td>Feed ration building and equipments</td>
<td>0.4</td>
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<tr>
<td>Electricity</td>
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<tr>
<td>chiken</td>
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<td>other equipments and costs:</td>
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<tr>
<td>feeding pots (SD000/35pot/1000hen)</td>
<td>0.7</td>
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<td>drinking pots(SD000/35 pot/1000 hen)</td>
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<tr>
<td>laying jars(SD000/20/1000)</td>
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<td>egg packing (SD000/2.5 dozen)</td>
<td>0.01</td>
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<td>Veterinary care</td>
<td>0.0425</td>
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<tr>
<td>labor (SD000/yr)</td>
<td>4500</td>
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<td>supply of electricity(SD000/month)</td>
<td>216</td>
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<tr>
<td>Total investment cost for 25 years</td>
<td></td>
<td></td>
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<tr>
<td>Total investment cost for one year</td>
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<table>
<thead>
<tr>
<th>Variable cost (SD000/year)</th>
<th>SD(000/fed)</th>
<th>Area</th>
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</thead>
<tbody>
<tr>
<td>Abu sabeen fodder crop</td>
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<tr>
<td>land preparation</td>
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<td>seeds</td>
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<td>fertilizers</td>
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<tr>
<td>labour</td>
<td>50</td>
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<tr>
<td>Subtotal cost</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Poultry feed concentrates | 70 | |
| Subtotal variable cost    |    | |
| Total cost (total investment cost/year +total variable cost/year) | | |

<table>
<thead>
<tr>
<th>Gross revenue/year</th>
<th></th>
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<tbody>
<tr>
<td>Abu sabeen</td>
<td>400</td>
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<tr>
<td>Eggs</td>
<td>0.2</td>
</tr>
<tr>
<td>total</td>
<td></td>
</tr>
<tr>
<td>marginal revenue (Gross revenue-total variable cost)</td>
<td></td>
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</tbody>
</table>
| Net profit (Gross revenue-total cost) | | 9£
<table>
<thead>
<tr>
<th>Years</th>
<th>Investment cost</th>
<th>Variable cost</th>
<th>Total cost</th>
<th>Abu Sabaeen</th>
<th>Poultry</th>
<th>Total revenue</th>
<th>Net cash flow</th>
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</table>

Results:
- NPV: SD 31.965 million
- IRR: 31%
- B/C: 1.4
- Benefit: SD 183.45 million
- Cost: SD 127.56 million
## Net Present Value and Benefit Cost Analyses

<table>
<thead>
<tr>
<th>Years</th>
<th>Investment cost</th>
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<th>Total cost</th>
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### Results

- **NPV**: (SD - 13.078 million)
- **IRR**: more than 57%
- **B/C**: 0.9
- **Benefit**: SD 134.3 million
- **Cost**: SD 139.4 million
4. 9. Discussion and Conclusion:

Based on the conceptual frame work, the results of the analyses gave indications on land degradation near the dumping sites plus negative impact on farms and animals including death of birds in poultry farms and disease of animal farms, damage of vegetable farms along the road to the site and significant effects on human health especially respiratory diseases and irritations.

In addition, this area is exposed to air, water and soil contamination, which will result on adverse pollution through time.

Though the problem of waste disposal in Sudan does not occupy the same dimension of other environmental problems, such as desertification, yet waste disposal in Sudan was in critical importance.

Humans produce waste that is dumped on the environment. Often, this waste is hazardous and dangerous to both human life and the environment.

The levels of dangerous wastes continue to grow as industries and individuals continue to be largely unaware of this major environmental problem.

As a result, many people and industries to prevent the creation of hazardous waste or to limit the negative effects it produces.
Individuals often throw out goods without realizing that they are headed for a landfill and could be dangerous to the environment. No matter where people put these hazardous waste materials, there is always a chance that they could find their way into the soil, and eventually into our bodies.

Corporations usually want to avoid the costs associated with hazardous waste. Consequently, they build landfills on site and fill them with waste, or sometimes pay to have their waste removed. Often, hazardous materials are transported to areas that accept the waste but money. It may prove very difficult to reduce hazardous waste in the future. Unlike many other environmental problems, waste creation is something people do not often think about.

In the future, people may have to reduce not only their generation of hazardous waste, but also their consumption of many products that end up in landfills.

4.9.1 Causes:

Hazardous waste is produced both on a huge scale by major industries and on a relatively small scale by individuals. No matter where it comes from, waste can be dangerous.

One of the main causes of the abundance of hazardous waste is that people do not realize how large a problem it is. Because it can be simply removed and sent to a landfill, it is often assumed that the problem ends there.
Industries have often displayed an unwillingness to find ways to deal with hazardous waste because of the expenses associated with it. Many industries and governments create crude landfills to store waste, and often just dump waste chemicals into nearby bodies of water or land. Chemicals used for industrial processes often create dangerous forms of waste. The amount of these chemicals has risen heavily in the past, as more areas of the world industrialize and new products are produced. Different chemicals are used in industries. Often, it is difficult and expensive to get rid of these chemicals and to store them in a way that does not endanger human life or the environment. Obviously, not all of these chemicals are dangerous, but many are and they do create serious problems.

**4.9.2 Solutions:**
The government can increase regulations on the disposal of hazardous waste to ensure that problems do not occur. It could also limit the amount of waste industries are allowed to produce, or provide incentives to create less waste.

After hazardous waste has been created, there are several actions that can be taken. Industries can break down chemical compounds into less dangerous forms, or store waste in ways that protect the environment from being exposed to the waste.
Not only major industries but individuals as well must form part of the solution. They can choose not to buy those products which require the production of hazardous waste, attempt to influence policy makers, and produce less hazardous waste themselves.

4.10 Cost/ benefit analyses

To many of the more extreme type of environmentalists, no level of human destruction of the environment is acceptable. They would demand an end to environmental problems such as pollution. Other more moderate environmentalists and many modern economists instead turn to what is known as cost-benefit analysis. This process seeks to compare the social costs and social benefits associated with a public policy decision.

Often this process is very successful. One problem with cost-benefit analysis is that not everything can be expressed in money terms. How much does it "cost" society if a person dies?

There are other problems as well. It is impossible to completely predict every result of a policy decision. In other words, not every factor can be taken into account in the analysis. Also, aspects such as health hazards have to be based on risk assessments because the exact outcome cannot be known beforehand. The fact that the concerns of future generations are not always represented in cost-benefit analyses also makes the process less reliable.
Ultimately, the goal of cost-benefit analysis is to enable a government policy that enforces environmental regulations up to the point where the marginal social cost and the marginal social benefit of these regulations are equal. This basically means that, for example, the government should continue reducing the amount of pollution allowed up to the point where further reduction of pollution levels would mean greater costs for polluters than benefits for society.

Cost-benefit analysis heavily affects modern government policy. In the United States, the Environmental Protection Agency (EPA) regularly employs cost-benefit analysis in making policy decisions. However, some laws, such as the clean air act, ignore cost-benefit analysis and set absolute standards.

4.12 precautions:

Preparing For Your Waste:
Before dumping of garbage, landfill sites should be prepared properly. When an area of the landfill is full, it is permanently capped with plastic layer. This cap prevents the formation of leachate due to rain water.

Monitoring programs:
There should be three monitoring programs:
1. Groundwater Monitoring: keeps track of the quality of the underground water below and around the landfill.

2. Surface Water Monitoring: keeps track of water in the ponds and streams near the Trail Road Waste Facility.

3. Landfill Gas Monitoring: keeps track of the movement and location of landfill gas. Probes below the caps measure gas pressure and composition.

There is a new world trend towards reducing the waste before managing or treating it, by using the 3Rs (reduces, reuse, recycle) which can:

1. Lower operating costs through more efficient use of raw materials.
2. Save waste disposal costs.
3. Show the society how to be environmentally conscious.
4. Conserve landfill space.
5. Conserve resources by reducing waste.
7. Clean up areas where waste may have spilled, leaked, or been improperly disposed.

As a matter of fact, collecting recyclable materials is just the first step in a series of actions that generate a host of financial, environmental, and societal returns.
Plate(1): Burning of toxic chemicals waste

Plate(2): Plastic containers from different industries
Plate(Γ): Heaps of glasses (non-degradable waste)

Plate(Σ): Loss of cultivated land
Plate(0): Damage of equipment

Plate(1): Damages of constructions
Plate(V): Abandoned farm due to waste accumulations

Plate(VI): Degraded lands on the margin between ranges and dumping site
Plate(9): ranges threatened by encroaching dumping site

Plate(10): Degrading rangelands due to creeping of waste
Plate(11): Land transforming towards desert condition by act of hazardous waste

Plate(12): Trench dumping within the agricultural land
Chapter five
Summary Conclusion and recommendations

5.1 Summary:
This study was conducted in Khartoum North industrial area depended on a sample of 60 individuals chosen randomly from factories in the area and residents near the dumping sites. The majority of respondents were from moderate level of education and poor standard of living.

5.1.1 The main objectives:
The overall objectives of this study were to assess the impact of hazardous waste of the manufacturing industries of Khartoum North on humans and animals health in the area, in addition to their other environmental implications over agricultural land and crop production and animal production in the study area. Specifically, the objectives address the assessment of the socio-economic status of the people in the area, the impact of waste on human health, on crop and on poultry production.

5.1.2 The main findings:
- The socio-economic status of the area was highly poor and the most of the population were labourers in the factories had low incomes that cannot enable them to satisfy their basic needs. These respondents had low to moderate level of education, and therefore may not have adequate awareness about their rights or even how to defend them. More or less, the degree of awareness in general is low in Sudan.
- The majority of the population was suffering from respiratory diseases especially after their
residence in the area, or due to their working in factories that released substances such as dust and gases irrespective of any precautions taken (e.g. textile, chemical, and wheat factories).

- Also there were skin irritations due to direct contact with chemicals or using the empty containers from factories waste or sometimes transmitted by insects that breed due to poor sanitary system in the area.

- Ingestion diseases are prevailing especially among children, because their soil is contaminated with different types of wastes. Children play and sometimes eat polluted soil particles, which might subject them to ingestion diseases. In addition to this, there were trace cases of cancer and mental or psychological diseases.

- In the agricultural fields the main problem is the loss of crops because waste covering the farms and preventing air and sun from in filtering and impedes their health and safe crop growth. Another problem found is related to irrigation channels that were blocked up by accumulating waste. Sometimes waste or dust released from loaders, while passing through narrow roads of the farms towards dumping sites, also cause
damages to the small vegetable fields near the roads.

- As it is clear in the photos shown in chapter four, there is a clear sign of degraded marginal area between the dumping site and the rangeland near it. Through time this would extend beyond control. The waste hazards also may extend to animals grazing on contaminated grass or eating directly from waste material, or drinking polluted water would adversely affect their health by toxic materials.

- Poultry farms found in the area were highly affected because birds are very sensitive to the surrounding polluted environment. It needs clean area and moderate temperature, which is impossible among smells, dust from land fill and heat from the burning in the dumping site.

- Since environmental issues are not among the top governmental priorities for the time being, then the main responsibility for mitigation pollution hazards falls on the civil societies organizations.

### 5.2 Conclusions

Based on the above the results it may be concluded that the pollution of hazardous waste would possibly have a
cumulative toxic and desertification effect through time. Such present mismanagement would create problems in the future harming the sustainability of natural resources at present and to the coming generations. Rehabilitation costs would be prohibitive and it would be advisable to keep an eye on these cases and encourage studies in this field.

5.3 Recommendations:

1. Raise the awareness about waste hazards through concerned civil societies.
2. Strict legislations and enforcement to implementation of laws.
3. Conduct environmental impact assessment (EIA).
4. Involve the target groups and affected community members in awareness programmes and encourage their participation in non-governmental-community based organizations.
5. Improve waste management which should involve the reduction, reuse, and recycle of waste in order to secure natural resources.
6. Improve and enforce Environmental Impact assessment (EIA) among polluters and decision makers in order to reduce hazardous waste effect on natural resources.
7. Make a plan to relocate the residential areas far from industrial areas and remove the dumping sites to more spacey non-productive lands.
5.4 **Suggested further research:**

1. Waste management.
   - Measurement of hazardous waste in polluted areas.

2. Economic understanding for the environmental issues.

3. Pros and cons of conducting of environmental impact assessment (EIA) for polluter, management authority and community organizations.
References


This questionnaire has been prepared for studying purpose for M.S.c degree to assess the effects of industrial waste on the environment.

1. Gender: □ male □ female

2. age:  15-25 □  26-35 □  36-50 □  <50 □

3. Educational level: graduate □ intermediate □ technique □ non □

4. Job: employee □ labor □ none □

5. Place of work: industrial area □ other place □

6. Health status: healthy □ ill □

7. kind of disease: respiratory diseases □ digestive disease □ others □

8. Date of illness: before coming to the area □
    After coming to the area □
    Non □

9. Family size: >3 □  3-6 □  7-9 □  <9 □

10. Workers in the family: >3 □  3-6 □  7-9 □  <9 □

11. Is there any patient in the family? yes □ no □
12. kind of disease: respiratory diseases □ digestive disease □ others □

13. Date of illness: before coming to the area □
   After coming to the area □
   Non □

14. Do you agree that existing near a source is harmful to your health?
   Yes □
   no □

15. Remedies cost: costly □ not costly □ possible □

16. Is there any affects on animal productions? Yes □
    no □

17. Is there any affects on agricultural productions? Yes □
    no □

18. Did the arable area decreased? Yes □
    no □

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