A DISSERTATION SUBMITTED IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTERS OF SCIENCE
IN PHYSICAL PLANNING

THE ENVIRONMENTAL IMPACTS OF THE
DISTRIBUTION OF INDUSTRIES IN
KHARTOUM METROPOLITAN AREA

CASE STUDY
TANNING INDUSTRY IN OMDURMAN AREA

SUPERVISOR:
Dr. MOHAMED YAQOUB SHADDAD

PREPARED BY:
MOHAMED MANSOUR MOHAMED

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بسم الله الرحمن الرحيم

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ظَهَرَ الْفَسَادُ فِي الْبَرِّ وَ الْبَحْرِ بِمَا كَسَبَتْ أَيْدِي

الناس لِيُذِيقُهُمْ بِعَصَدَةٍ مَّنْ أَلَّهُ عَمِلَوْا لَعَلَّهُمْ يُرِجُعُونَ

صدق الله العظيم

سورة الروم: آية 41
DEDICATION

I dedicate this humble work to those who are concerned with environment, to those who wish to live in a clean and healthy atmosphere.
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All gratitude is for Mighty ALLAH, who guided me through all stages of this journey, without his inspiration I would have not been sitting on my chair and writing this acknowledgement right now.

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Mohamed
ABSTRACT

Sudan is a unique country which lies in Africa and has boundaries with nine African and Arabic countries. These vast boundaries eased immigration to Sudan from the surrounding countries which had its tangible impacts upon the increase of population in Sudan. Also, it worth mentioning, the internal immigration to Khartoum, the capital, from the surrounding regions shared an active part in increasing the population in Khartoum Metropolitan Area.

With the increasing ratio of population in the metropolitan area, which leads to the increase of consumption and purchasing power, together with the existence of labor as a result of internal and external migrations, several industries had been established. These industries were located amongst certain areas due to some leading factors.

Among the factors that lead to the establishment of these industries in Khartoum Metropolitan Area we find that low cost of production due to the provision of the basic infrastructure beside the fluent marketing system. These factors, as examples, had lead to the increase of the industrial areas in Khartoum Metropolitan Area.

Most of these industries were established and distributed without proper and essential planning considerations. As a consequence of such improper distribution of industries many environmental problems had emerged and had a black shadow on different environmental issues.

This study tries to investigate and assess the environmental impacts resulted from the improper distribution of industries amongst Khartoum Metropolitan urban area.

The study took place in certain areas which are: Khartoum Industrial Area, Khartoum North Industrial Area and Omdurman Industrial Area, with special focus on Omdurman area as it represents the main study area of tanning industry in Khartoum Metropolitan area. Choice of tanning industry was set depending on certain criteria such as the future importance, vitality and Viability of this industry on the Sudanese economy. On the other hand, this industry has its severe environmental impacts which should be investigated and revealed. Field work included questionnaires, worksheets, setting maps, voice records for citizens, photographs as well as observation.
The study succeeded in establishing evidence that there are many environmental problems occurred as a consequence of inadequate planning as well as the unbalanced administrative decisions.

Emergence of such results leads to conclusions and recommendations which confirm the need to new administrative methods and planning concepts to cope with such environmental problems.
الخلاصة

السودان بلد متفرد يقع في أفريقيا، وله حدود مع تسع من الدول العربية والأفريقية، مما سهل الهجرات إلى السودان، والذي كان له أبلغ الأثر في زيادة السكانية للسودان عامة ووللمتاجرة الخطروم، مع الهجرات الداخلية، خاصة، وעם زيادة السكانية للخطروم، العاصمة، وزيادة الشريحة الاستهلاكية بها إلى جانب وفيرة الأيدي العاملة، و كنتيجة لهذه العوامل، مع غيرها، قامت العديد من الصناعات المختلفة والتي تمكنت في بعض المناطق دون غيرها.

من ضمن العوامل التي أدت إلى قيام هذه الصناعات في الخطروم انخفاض الكتلية الإجمالية للمنتج نسبة لتوفير البنية التحتية الأساسية إلى جانب التسوية الأسهل للمنتج نسبة لزيادة السكان. هذه العوامل، على سبيل المثال لا الحصر، أدت إلى كبر الرقة الصناعية والانتشار في مناطق العاصمة الثلاث.

معظم الصناعات التي أنتجت تم تأسيسها وتوزيعها دون الرجوع لأساسيات التخطيط السليم. وكنتيجة للتوزيع غير الصحيح تتكمل الصناعات ظهرت الكثير من المشاكل البيئية في المنطقة، والتي رمت بظلها السوداء على مختلف النواحي البيئية.

هذا الدراسة حاولت البحث والتنقيب لكشف الآثار البيئية المرتبطة على التوزيع غير الملائم للصناعات في منطقة العاصمة الخطروم.

تمت الدراسة في مناطق محددة من العاصمة، وهي: منطقة الخطروم الصناعية، منطقة الخطروم البحري الصناعية و منطقة امدرمان الصناعية، مع التركيز على منطقة امدرمان لأنها تمثل المنطقة الرئيسية لصناعة الدباغة في الخطروم العاصمة. اختيار هذه المناطق الثلاث كان على أساس أنها تمثل المناطق الصناعية الرئيسية في الخطروم. اخيار صناعة الدباغة كموضوع الدراسة كان على أساس أنها تمثل أهمية مستقبلية في المستقبل الاقتصادي للسودان. (في ظل التغيرات الأخيرة) على صعيد آخر، هذه الصناعة لها من الآثار البيئية ما يجب دراسته وإعطاء لائحة عامة ليتم تダーقه وإيجاد الحلول له. لغرض الدراسة، تم إجراء عمل ميداني شمل نشر الاستبيانات، رسم الخرائط، التسجيلات الصوتية، الصور الفوتوغرافية والملاحظات.

نجح الدراسة في إثبات الفرضيات، وهي أن هناك العديد من المشكلات البيئية في منطقة الدراسة، وأن هذه المشكلات البيئية ناتجة عن عدم اعتبار الأسس التخطيطية السليمة واتخاذ القرارات الإدارية غير المتوزنة.

إثبات هذه النتائج أدى إلى بعض الاستنتاجات والتوصيات التي تؤكد الحاجة لطرق إدارية جديدة وفاطم تخطيطية عميقة تفي بالحاجة إلى حلول جذرية للمشكلات البيئية الراهنة.
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Chapter I

INTRODUCTION

1.1 Problem Identification and Reasons for Choice

Physical environment, in its general meaning, can be defined as the surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation. The environmental impact is defined as: any change to the man, environment, whether adverse or beneficial, wholly or partially resulting from an organization’s activities, products or services (1).

Environment, generally, was subjected, and is being subjected, to the violation of man. This violation was not towards natural environment only, but also towards the man-made one.

Man has his fingerprint on the environment in several tragic ways. He establishes factories and workshops in the residential territories. He exploited the nature violently for his own benefit without considering or paying any respect to human habitats.

Human health and public interests were not considered or even remembered when setting the new industrial plants. As is known, geographical and time factors, as well as orientation, are to be considered in the developing countries (especially Sudan) in order to encourage the intention of making a successful turning point. This turning point is to be towards prosperity as well as human development so as to grasp the global move of sustainable development. Such considerations are of great importance and vital in planning the industrial areas.

This importance is due to the direct impacts of industries upon the environment, whether natural or man-made.
Misdistribution of industries, especially among residential areas and crowded spots, has its observable impacts on the environment. The left-over of gaseous, liquid and solid wastes emitted as a result of the industrial process have negative consequences upon man, animal and plant. These consequences range from different diseases among living creatures to the ultimate destruction of national economy.

1.2 Hypotheses

There are so many environmental problems in the study area. These problems have occurred because the residential areas are so close to, even mixed with, the industrial areas due to the creeping of the residential areas towards the industrial zones.

This has been realized through the clear environmental impacts in the study area, the lack of essential services related to the industrial area (e.g. sewage disposal systems, surface drainage….etc), the relatively high percentage of sicknesses and accidents due to the lack safe and sufficient planning and administration of the industrial plants.

1.3 Goals and Objectives

Industrial areas, in many countries, are being established amongst certain unsuitable sites. Certain consequences emerge as a result of such misdistribution of industries.

The purpose of this study is to clarify and discuss these consequences of all environmental impacts of the distribution of industries in Khartoum Metropolitan Area.

These impacts will be discussed in order to get a clear perspective of the current environmental conditions in the area.

The results of the study will be analyzed to obtain up-to-date facts of the actual indicators of pollution in the area studied. In the light of these indicators, positive response will take place by those in charge and
other environmental bodies. Kind and size of response depend mainly on the amount of damage caused by these industries. Type of response depends, also, on the awareness of those in charge and how they take care of such a disaster.

1.4 Methodology

In studying the environmental impacts of the distribution of industries in Khartoum metropolitan area, the researcher intends to clarify, uncover and investigate the problems concerned with the distribution of industries among certain vicinities with respect to the wastes these industries produce, and the means by which these wastes are disposed.

To achieve this pragmatic approach, certain methods are to be followed through collection of primary data and the consultation of secondary sources.

The following methods will be used to carry out the study:

1.4.1 Data Collection

In the process of collecting preliminary data for the study various data sources had been used. This includes visits to public libraries such like Sudan Library and library of SECS. Visits to ministries and governmental authorities were of great gain to the study since they are considered to be main sources for new data.

Also, internet sites were of great advantage since they contain up-to-date information concerning environmental issues and awareness.

Consultation of private bodies and sectors, including organizations and environmental societies, provided the study with a special variety of opinions and discussion points.

1.4.2 Questionnaire
In the intention of accurate interviewing, a questionnaire will be organized. The main purpose of the questionnaire is to collect data from the directly affected members of the society, residents and workers of the areas under study. The findings from the questionnaire will be analyzed and compared to other findings arrived at other tools and methods of research.

Certain industrial areas will be selected, within Khartoum Metropolitan Area, to conduct the research considering certain factors and conditions.

The matters of mix-use of land-use, health hazards and the degradation of resources will be of concerned.

The proposed areas are:

1. Khartoum Industrial Area.
2. Khartoum North Industrial Area.
3. Omdurman Industrial Area.

With special emphasis on Omdurman area, as it will be selected as case study.

1.4.3 Interviews

Two different kinds of interviews will be conducted:

a. Interviews with employers and administrators of the industrial plants.

b. Interviews with citizens of the selected areas.

c. Interviewing environmental organizations such as NHCEHR and IES.

Personal observations during the site visits will also be utilized. These observations, supported with photographs and own criticism, will be of great help to the study in obtaining insights into the reality of the environmental problems in Khartoum metropolitan area.
1.4.4 Worksheet

A worksheet will be designed to gather information to help unearth certain points, especially through the intended case study assessment, which can not be checked through regular techniques. The worksheet is to handle certain issues such as air emissions, solid wastes, water pollution and others.

1.5 Organization of the Research

The study consists of five chapters through which the entire idea of the dissertation is elucidated.

Chapter One sets the idea of the research, handling the identification of the problem concerned and the ideas that have been hypothesized. Main goals and objectives of the research are also illuminated. The methodology followed in conducting the study is explained in depth.

Chapter Two falls into six parts containing the theoretical background that involves planning of the industrial areas, environmental problems of Khartoum Metropolitan Area and the impact of the industrial areas on sustainable human settlements

Chapter Three discusses the industrial wastes in Khartoum metropolitan industrial areas. Special attention is given to the wastes of the power stations. Also a general look is given to the water related aspects of the law.

Chapter Four deals with case study, which is the Tanning Industry in Omdurman area. Issues concerned with the case study are to be discussed in this chapter.

Chapter Five forms the conclusion and recommendations of the study.
Chapter II

THEORETICAL REVIEW

2.1 Impact of Industrial Areas on Sustainable Human Settlements

2.1.1 Introduction

Sustainable Development is defined as; “meeting the needs of the present without undermining the resource and ecological base for future
“Sustainable human settlements development in an urbanizing world” is one of the two purposes of the Second United Nations Conference on Human Settlements (Habitat II) (the other one is “Adequate Shelter for All”).

Cities are clearly central to meet the goals of Sustainable development. This can partially be achieved through development of industrial areas which has greater impact on human settlement. The sustainability of planet Earth will not be achieved unless human settlements, and especially cities (including industrial areas), are made economically buoyant, socially vibrant, and environmentally sound. The municipal level of Government is an effective partner in making human settlements viable, equitable and sustainable, as its level of administration is closest to the citizen\(^{(12)}\).

### 2.1.2 Sustainable Land Use

Land resources are the basis for living systems and provide soil, water, and the opportunity for all human activities. In rapidly growing urban areas, access to land is rendered increasingly difficult by the conflicting demands of housing, industry, commerce, infrastructure, transport, and the need for open spaces and green areas. To avoid unbalanced, unhealthy, and unsustainable growth of human settlements, it is necessary to promote land use patterns that a precondition for minimizing transport demands, saving energy and protecting open spaces. Healthy urban density and mixed land uses are of prime importance and serve as important guidelines for urban development.

### 2.1.3 Sustainable Transport and Communication Systems

Transport and communications systems are the key to the movement of goods, people, information, and ideas, and access to markets, employment and facilities and land-use, both within cities and
between cities, and in rural areas. Transport is a major consumer of non-renewable energy as well as land and is a major contributor to pollution, congestion, and accidents. Improved transport and land use policy and planning can reduce the ill effects of current transport systems. Priority should be given to reducing the need to travel, through appropriate land use patterns and public transport policies (5).

2.1.4 Harmful Materials and Their Effects (15)

Asbestos pipes, asbestos sheets for building construction, and other products, are all manufactured in Khartoum North. But this is no longer so. Despite its past manufacture, the effect of asbestos is still hot. Asbestos is found in the Sudan and can be mined. This substance is useful but dangerous. Inhaled asbestos dust can cause asbestosis (fibrosis, thickening and scarring of lung tissue), lung cancers and mesothelioma (an otherwise rare cancer of the linings of lungs and abdomen), all of which are often lethal and may strike up to several decades after exposure. Mesothelioma (cancer of lung’s tissues) cases have even been reported among members of asbestos workers who breathed in dust from contaminated clothing! Asbestos should be handled with extreme caution. In a number of countries the most dangerous form, blue asbestos, has been banned, but it is used in the Khartoum factory. Sweden, for example, has virtually stopped the use of all forms of this product, and the US government proposes to do the same (4). Sudanese workers seem to be unaware of the dangers of asbestos dust. Little care is given to the disposal of asbestos wastes and empty asbestos sacks are reused as housing materials.
2.2 Planning of Industrial Areas
2.2.1 Definition of Industrial Areas

An Industrial Area is an area of land developed for use by a number of industrial enterprises. It is established and controlled according to a plan incorporating zoning and restrictive regulations. The management, organization and maintenance of the Area is for the benefit of both, the developing organization, and the tenants; and it usually provides some, or all of the following facilities for use, sale, rent or lease: Streets and roads, rail-road tracks, water, power, sewerage and sanitation, fire stations, blanks, post and telecommunication, medical facilities, recreation facilities, common service facilities (workshops, storage, ...etc), arrangements for technical and economic assistance (advice - demonstration - training), factory buildings (general-purpose or "custom - made"), and housing for labor\(^{(1)}\).

2.2.2 Types of Industrial Areas

Industrial Areas can be classified according to\(^{(4)}\):

1. Types of Facilities Offered: -
   - Simple Estate.
   - Improved Areas.
   - Built - up areas.
   - Improved Built-up Areas.

2. Purpose: -
   - Multiple Industry Areas.
   - Investment - Limit Areas.
   - Functional Areas.
   - Ancillary Industrial Areas.
   - Work - shed Areas.
   - Training Areas.
   - Staggered Industrial Areas.

3. Size: -
   a- Area Classification:
      - Very Large Areas (over 500 acres). (1 Acre = 0.95 Feddan)
• Large Areas (101 - 500 acres).
• Medium Areas (51 - 100 acres).
• Small Areas (up to 50 acres).

b- Classification according to Housing Capacity:

• Large Areas (more than 300 units). (Every unit holds 5 workers)
• Medium Areas (between 300 and 50 units).
• Small Areas (less than 50 units).

4. Location: -

• Urban Industrial Areas (near big cities).
• Semi - Urban Industrial Areas (near small and medium sized towns).
• Rural Industrial Areas (near villages in rural areas).

5. Degree of Planning: -

• Fully Planned Areas.
• Partly Planned Areas.
• Open Industrial Areas.

2.2.3 Integrated Economical & Social Objectives in Establishing Industrial Areas

Distinguishing between purely economic and purely social objectives in Industrial Areas Programs is not easy since both spheres overlap to a large degree and are interdependent.

2.2.3.1 Social Objectives: -
Mainly social stability of the community through:

   Employment, increased income (and as a result a certain standard of living: food, clothing, accommodation, education, recreation, pleasure ...etc.), which leads to the development of backward areas combined with the improvement of living and working conditions through slum-clearance, city planning, services provision ...etc.

2.2.3.2 Economic Objectives: -

The primary objective is a balanced economic development by the pursuit of a decentralization policy. A purely economic objective in
establishing Industrial Areas is the profit motive. Either directly through the sale or rent of developed sites, and/or the provision of services to occupants, or indirectly through expected higher freight revenues from transportation to and from an area\(^{(6)}\).

2.3 Khartoum Metropolitan Industrial Areas

There are about 20 industrial areas in Sudan\(^{(16)}\). Greater Khartoum includes three of them: Khartoum, Khartoum North, and Omdurman industrial areas. These areas are considered as the most important ones in the country\(^{(16)}\). The following paragraphs give a brief description of their environmental conditions.

2.3.1 Khartoum Industrial Area

Khartoum Industrial area is one of the oldest areas in the Sudan. Recently the area extended until it reached Al Shajarah residential area at the Southern part of the city. The area suffers from bad planning, weakness of sewerage disposal systems and waste treatment as well as the surface water disposal.

2.3.2 Khartoum North Industrial Area

The area is located in the Southeast part of the Khartoum North Town. The area is now surrounded by residential extensions from Shambat to the North to Kafori Southwards.

There are 600 industrial units scattered in the area without any considerations of the type of industry. Moreover, few numbers of these units are connected through a network to the treatment plant at Al HajYousif. The network was exposed to damages due to occlusion of the pipes and stopping of pumping stations\(^{(16)}\).

2.3.3 Omdurman Industrial Area
This area is located in the Northwest part of Omdurman Town, neighboring residential areas from all sides.

There is no waste treatment station and sewerage disposal system in the area and it has a poor road network. Disposal of wastes takes two main methods; either they are collected by private tankers which the citizens hire or primitively by dumping the wastes in a big hole outside the house. It worth mentioning that tankers cast off the wastes outside the city on open areas.
2.4 Urban Environmental Problems

2.4.1 Introduction

As centers of population and human activities, cities consume natural resources from both near and distant sources. They also generate waste that is disposed of both inside and outside the city. In the process, urban areas generate environmental problems over a range of spatial scales: the household and workplace, the neighborhood, the city, the wider region, and the globe. Urban environmental problems also create a range of social impacts. They may impair human health, cause economic and other welfare losses, or damage the ecosystems on which both urban and rural areas depend.  

Environmental problems vary from city to city and region to region and are influenced by such variables as a city's size and rate of growth, income, local geography, climate, and institutional capabilities. The
following are environmental problems most prominent in developing world cities.

### 2.4.2 Urban Population Growth

The world is in the midst of a massive urban transition unlike that of any other time in history. Within the next decade, more than half of the world's population, an estimated 3.3 billion will be living in urban areas \(^{(12)}\).

In 1975, just over one third of the world's people lived in urban areas. By 2025, the proportion will have risen to almost two-thirds. The most rapid change is occurring in the developing world, where urban populations are growing at 3.5 percent per year, as opposed to less than 1 percent in the more developed region \(^{(12)}\).

### 2.4.3 Water and Sanitation

One of the greatest threats to human health in the developing world is the lack of adequate water and sanitation services. In 1994, at least 220 million people lacked a source of potable water near their home. The proportion of the urban population covered by sanitation services is even smaller. More than 420 million urban residents do not have access to even the simplest latrine \(^{(5)}\).

Inadequate access to water and sanitation facilities is the main cause for the intestinal sicknesses, transmitted by feces, so prevalent in developing countries. Two of these diseases, diarrhea and intestinal worm infections, account for an estimated 10 percent of the total burden of disease in developing countries \(^{(5)}\).

### 2.4.4 Waste-Water Disposal System

In the developing world, it is estimated that more than 90 percent of sewage is discharged directly into rivers, lakes, and coastal waters without treatment of any kind \(^{(7)}\). Disposal of domestic wastewater
remains a problem, although by no means as severe, in wealthier regions as well.

2.4.5 Urban Air Pollution

Worldwide, more than 1.1 billion people live in urban areas with unhealthy air, as a result of a cocktail of pollutants released from industrial, energy, and vehicular sources. The World Bank estimates that if particulate levels alone were reduced to WHO guidelines, between 300,000 and 700,000 premature deaths per year could be avoided globally. That is the equivalent of roughly 2 to 5 percent of all deaths in urban area \(^{(4)}\).

Urban air pollution not only impairs human health but also damages crops, vegetation, and man-made structures, including historic monuments.

Urban air quality has generally deteriorated throughout the developing world. The reasons are increasing power generation, rising industrial activity, and rising motor vehicle use—especially of poorly maintained vehicles that use leaded fuel.

2.4.6 Solid and Hazardous Wastes

Cities generate tremendous amounts of solid waste, and those amounts increase with income. In cities of the developing world, an estimated 20 to 30 percent of the solid waste generated remains uncollected, even though up to one half of local operational expenditures often go towards waste collection \(^{(12)}\). Uncollected domestic waste is the most common cause of blocked urban drainage channels, increasing the risk of flooding and vector borne diseases. In some cities, refuse is often mixed with human excrement, which facilitates the spread of disease, especially among children and waste pickers.
The lack of emissions standards or enforcement of regulations in many developing nations compounds pollution problems. Illegal dumping and improper disposal of toxic and hazardous wastes are common. In addition, industrial activity in the developing world tends to be concentrated in relatively few locations, often close to city centers (8).

2.4.7 Noise Pollution

Noise is unwanted sound; it is derived from the Latin word "nausea," meaning seasickness. Noise is among the most pervasive pollutants today. Noise from road traffic, jet planes, jet skis, garbage trucks, construction equipment, manufacturing processes, to name a few, are among the unwanted sounds that are routinely broadcast into the air. The problem with noise is not only that it is unwanted, but also that it negatively affects human health and well being. Problems related to noise include hearing loss, stress, high blood pressure, sleep loss, distraction and lost productivity and a general reduction in the quality of life and opportunities for tranquility. Sound is quantified by a meter, which measures units called decibels (dB). The adjusted sounds are called "A-weighted levels" dB (A), (55dB (A) considered acceptable) (4).

Although the noise problems affect urban residential areas in general, they are of particular significance to the industrial areas, particularly in Greater Khartoum where industrial areas are surrounded by residential areas.
2.5 Environmental Problems of Khartoum Metropolitan Area

This section will focus on the environmental problems of Greater Khartoum, since it is the largest urban conurbation in Sudan. It contains about 76% of Sudan's industrial establishments and about 80% of its commercial transactions (Abu Sin & Davies 1991). Also it can be mentioned that Greater Khartoum manifests most of the symptoms of deteriorating urban environmental conditions.

2.5.1 Rapid Urban Growth

The 1956 census recorded a population of just over half a million people (Sudan First Population Census 1955/56). By 1983 this had risen to 1.8 millions (Sudan Third Population Census 1983), and in 1993 to 3.8 million persons (Sudan Fourth Population Census 1993) (17).

In the period 1956 to 1983 the population increased by about 1.3, an average of 8.8% a year. From 1983 to 1993, there was an increase of 2 million, an average of 15% a year.

Greater Khartoum has become increasingly the dominant urban center in the country with its population, rapidly, growing. The proportion of Sudan's population living in the capital region rose from 4.9% in 1956, to 8.7% in 1983 and to 14.4% in 1993. It has throughout been the major area of attraction, receiving 14.4% of all the internal migrants from other region and states since the year 1955. This increased to 39% in 1983 and to 50.1% in 1993 (21).

2.5.2 Water Supply

There are six water works in Greater Khartoum State (dependent on the Nile), with total capacity of 207000 m³/day. This quantity may be increased to 21500m³/day in summer season or decreased to 143000
m³/day in flood season. There are also a number of boreholes scattered all over the city producing 222,000 m³/day as maximum capacity (14).

At squatter areas (at the fringes and out-skirts) of the city, 190 distribution points (Akshak) have been established for selling water supply to these areas. (21)

The following are the main problems associated with water supply provision in Greater Khartoum (14):

1. The bad quality in flood season.
2. The network is old in many parts of the city, so that 35%-25% of the total quantity is lost due to breakage and seepage from the metal pipes.
3. In many cases, people have had to connect private house pumps to obtain water from the network. Since the system of the network is old, fittings have corroded. When private pumps are working, this leads to generation of negative heads in the net and sucks dirt and rust into the system leading to the pollution of the water within the whole system.
4. The deficiency of electricity supply to operate the boreholes is one of the major problems associated with the water supply.

2.5.3 Sewage Disposal

The majority of houses (more than 95%) in Greater Khartoum are served by the traditional systems, which are exemplified by the pit latrines and septic tanks and disposal wells. They are closely associated with fly breeding, bad odors, and possible contamination of soil as well as ground and sub surface water (21).

The remaining 5% of the city population are now served by either poorly functioning and over loaded municipal sewerage systems, or by wells and septic tanks (e.g. Riyadh and Gereif).
2.5.4 Garbage Disposal

A study carried out by the National Council for Research, estimated garbage generation in Greater Khartoum to be at the rate of 0.5 kg per person per day \(^{(20)}\). Considering the big-size population, a huge quantity of garbage is generated each day. The available new companies, machines, and budget could not cope with such a scale of a problem.

2.5.5 Surface Drainage

Most areas of Greater Khartoum are faced with serious drainage problems. The problem is especially acute in squatter areas where there are no drainage systems. As well, these settlements have expanded onto natural drains of rainy season. Due to lack of drainage, many ponds and pools are formed during the rainy season in most areas. Domestic wastewater and garbage are disposed into drains near residential areas and this pollutes storm water pools. Ponds and pools are often breeding sites for disease vectors such as mosquitoes, and they create many problems for those living nearby \(^{(21)}\).

2.5.6 Environmental Health Service

The environmental health services in Greater Khartoum (including industrial areas) have witnessed a serious setback during the last two decades. This has been reflected in the alarming increase in the prevalence of some infectious environmentally associated diseases, such as malaria and typhoid. Malaria and typhoid are becoming a nightmare for the residential areas including those adjacent to the industrial areas. At present, the prevalence of malaria is estimated at 20% of the population \(^{(15)}\).

2.5.7 Air Pollution

Air pollution due to oil burning in the industrial areas in the city and Bahri power station (Burri power station had its share in the pollution
but it is no longer functioning due to its damage), as well as from traffic and indiscriminate burning of refuse is ever on the increase. However, the effect until now is localized in the industrial areas, power stations, and high traffic areas. Unfortunately, all industrial areas and power stations are sited within the heavily populated part of the city\textsuperscript{(15)}.

Radiation from high-tension transmission lines is considered to be the main reason for some effects upon people. These effects vary depending on the distance between these lines and the populated areas. In general, the effects include brain damages, different kinds of cancer, such like Leukemia and Thyroid, and electrical shocks.

Chapter III

INDUSTRIAL WASTES IN KHARTOUM METROPOLITAN INDUSTRIAL AREAS

3.1 Introduction

The functioning of a modern economy and contemporary society is dependent on the availability of electricity and the reliability of supply. However, as standards of living continue to rise, growth in demand in all sectors must be reduced if sustainable development is to be achieved.

Electricity generation is traditionally associated with burning fossil fuels. This gives rise to the emission of greenhouse gases (notably carbon dioxide) and acidifying gases (sulphur dioxide and nitrogen oxides) which have damaging effects on biodiversity \textsuperscript{(15)}.

Pollutants and gases emitted from power stations contribute to the deterioration process of environment and represent a sufficient percentage of the hazardous pollutants which influence the health of the human beings. Table (1) and (2) show some major pollutants and gases and their impacts on health \textsuperscript{(5)}.
Table (1): Some Major Pollutant & Gases (30)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulpher Dioxide</td>
<td>Power stations &amp; refineries</td>
</tr>
<tr>
<td>Smoke &amp; Dust</td>
<td>Iron industries, cement industry…etc.</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>Burning fuel</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>Burning fuel</td>
</tr>
<tr>
<td>Nitrogen Oxides</td>
<td>Nitric Acid Factories</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Ammonia and chemical fertilizers factories</td>
</tr>
<tr>
<td>Carbon Trioxide</td>
<td>Acid factories</td>
</tr>
<tr>
<td>Sulpher &amp; Sulphide</td>
<td>Power stations</td>
</tr>
<tr>
<td>Chlore &amp; Hydrogen</td>
<td>Factories of chlore, ammonia and chrome</td>
</tr>
<tr>
<td>Chloride</td>
<td>Chemical Laundries</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td></td>
</tr>
</tbody>
</table>

Table (2): Impact0s of Some Pollutants & Gases on Health (30)

<table>
<thead>
<tr>
<th>Gas or Pollutant</th>
<th>Health Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulpher Dioxide &amp; Other Sulpher Oxides</td>
<td>Asthma &amp; Bronchitis, Pneumonias, irritant, heart diseases, psychiatric diseases in children</td>
</tr>
<tr>
<td>Dust &amp; Small Sized Particulates</td>
<td>Asthma &amp; Bronchitis, irritant for eyes and respiratory system, limited sight in 25mg/l, affect human health in 200mg/l concentration.</td>
</tr>
<tr>
<td>Ozone</td>
<td>Lung damage</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>Poisonous especially for heart patients in 30mg/l conc. May damage central nervous system</td>
</tr>
<tr>
<td>Nitrogen Dioxide</td>
<td>Lung damage, poisonous 4 times than nitric acid and starts at 0.05mg/l conc.</td>
</tr>
<tr>
<td>Pb (Lead)</td>
<td>Accumulates in the body, may</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Hydrogen Sulphide</strong></td>
<td>Irritants allergen, increases mortality rate.</td>
</tr>
<tr>
<td><strong>Hydrocarbons</strong></td>
<td>Affect vision by making smoke clouds in 15 – 25mg/l conc.</td>
</tr>
<tr>
<td><strong>Asbestos</strong></td>
<td>Asbestosis, carcinogen</td>
</tr>
<tr>
<td><strong>Brelium</strong></td>
<td>Lung damage, Breliosis, in 0.01mg/l conc.</td>
</tr>
<tr>
<td><strong>Ether</strong></td>
<td>Anesthetic, poisonous, carcinogen</td>
</tr>
</tbody>
</table>

Most forms of electricity generation, whether by fossil fuels, nuclear energy or renewables, will have impacts on the environment. These may be due to the extraction and production of fuels, the location and construction of generating plant and associated infrastructure (including transmission lines), the emission of pollutants and production of wastes during operation, and as a result of eventual decommissioning. The implications of a large number of small, locally-based schemes and fewer, larger power stations also need to be assessed. It is important that the environmental impacts of all forms of generation are minimized, through the use of mitigating technologies and regulatory safeguards, so that the quality and diversity of Sudan's wildlife and natural features is maintained and enhanced.

In the development of energy policies and programmes to meet the social, economic and environmental needs of the 21st Century, consideration must be given to measures for driving down demand, as well as to the most appropriate means of generating electricity.
The key to effective change is the creation of behavioral patterns in which the conservation and efficient use of energy are the norm. A culture of "doing more with less" must be underpinned by a strong policy framework from Government, and responsible action by producers and consumers alike.

3.2 Industries in Sudan

Here are some examples for industries in Sudan which produce wastes and in need of monitory and effective control \(^{(29)}\):-

- Weaving industries.
- Leather and tannery industries.
- Cement industries.
- Power generation.
- Petrol refining.
- Sugar industry.
- Food industry.
- Dairy industry.
- Paper industry.
- Soap and chemical detergents industries.

Also we can enlist hospitals for their dangerous wastes.

The industrial wastes, especially the solid wastes, found no consideration from the authorities; this is due to the economic weakness and the technical disability, so the matter of collecting, transporting and discarding the industrial wastes are left to the owners of the projects to find an appropriate mechanism to get rid of it or to coordinate with the authorities to handle it.

An example for that is what happened for the asbestos wastes of the former Bahri Factory and the attempts of Doroshab area, the inhabitants of which tried to use these wastes in different ways \(^{(29)}\). Also what happened in Elshajarah asbestos factory and the attempt to bury the wastes inside the factory should be considered.
The unbelievable crisis is formalized in that most of the industrial plants in Khartoum North Industrial Area (and some from Khartoum Industrial Area) get rid of their liquid wastes in a very primitive and unauthorized way. They have invented a civilized method to dispose their wastes out of sights. Liquid wastes of these plants are collected privately and transported to the south of Al-Samrab area where they are disposed in a very huge dump which (they) called Al-Samrab Dump (Plate (4)). Liquid wastes of almost every kind are mixed in this dump allowing very toxic gases to be emitted which affect both air and soil. The impact of such behavior is represented in the pollution of the air and the infertility of soil as well as the damage of the underground water.

The real hazard is that when these liquid wastes, that contain various chemicals, leak deeply inside the ground and reach the underground water. When considering that many small-scale agricultural schemes livestock barns are distributed around this area, just then one can imagine how critical this action is.

Much work and discussion have been held by several organizations and societies (such as Sudanese Environment Conservation Society) concerning Al-Samrab Dump but it seemed immune against all rules and regulations.
Plate (4): Al-Samrab
Wastes’ Dump
Plate (5): Leakage from Al-Samrab Dump. Notice how the surrounding soil has been damaged.

Beside all that, a lot of emptied containers of chemicals, sacks, barrels…etc, are left in open garbage places or given to workers to use them for domestic purposes.

Regarding the gaseous wastes, we find that it is almost marginalized; perhaps because its impacts are not immediate.

Stacks and exhaust smoke-pipes and what they carry to the populated areas are quite a threat, especially if the factories raise the operation power.

3.3 The Industrial Wastes

Most scholars and politicians are convinced that the only way for the developing countries to achieve the liberation from the bonds of poverty and suffering is through industrialization. Industries help in realizing economic and social development by (12):

- Variety of income sources;
- Creating job opportunities;
- Increase in the public and individual income.

No doubt that the industrial countries enjoy good education and health services, nevertheless, industry may itself be a serious danger and an endless hazard if the environmental precautions are not properly taken into consideration. The industrial activities may lead to various disasters (12):

- Chemical accidents;
- Explosions;
- Working accidents;
- Profession diseases.

It is really unfortunate to say that industry in the developing countries (Sudan is on the top of the list) is very poor in regards to the execution of planning and predicting of long and short-term negative environmental consequences. This confusion of procedures can be noticed in the procedures of approving factories or industrial plants. There is not much care in setting the basis and the criteria upon which the approval is given to these factories or industrial plants (e.g. a soap factory, oil refinery or an asbestos factory), but rather than that all attention is paid to some routine official procedures like checking maps and data written in the official forms regardless of the techniques employed or the positive and negative impacts on the environment.
To avoid such procedural confusion, deep solutions should be placed to face some certain factors such as:

- The absence of a uniform effective mechanism.
- Overlapping of authorities and poor coordination.
- Insufficient efficiency in this discipline.
- Prohibiting public participation.
- Other factors regarding basis, criteria…etc.

Of course the industrial wastes vary according to the industrial activity in regards of:-

- Quality and quantity.
- Utilized technology.
- Number of shifts and operations.
- Existence of environment health devices and monitoring them periodically.
- Legislations which control quality.
- Efficiency of executive mechanism regarding:-
  
  a. Qualified labor.
  b. Existence of monitory mechanism.
  c. Existence of running essentials.
  d. Existence of evaluation mechanism.

Fortunately, among the billions of tons of solid industrial wastes, only 2 – 3 % may cause serious environmental hazards, and most of it is in Europe which started to stimulate the third world countries, especially those politically and/or economically unstable, to accept their wastes as harm-free substances to be used as row materials or any other utilization (5). Table (3) shows some industries in Sudan and their wastes.
<table>
<thead>
<tr>
<th>Industry</th>
<th>Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>Seed, crusts…etc.</td>
</tr>
<tr>
<td>Sugar</td>
<td>Cane, cleaning water…etc.</td>
</tr>
<tr>
<td>Leather</td>
<td>Chrome, Zink, leather, fats, gases, rotten odor…etc.</td>
</tr>
<tr>
<td>Mills</td>
<td>Cellulose</td>
</tr>
<tr>
<td>Tires</td>
<td>Organic &amp; inorganic wastes, acids…etc.</td>
</tr>
<tr>
<td>Slaughter Houses</td>
<td>Blood, bellies, bones…etc.</td>
</tr>
<tr>
<td>Poultry</td>
<td>Feather, cleaning water, blood, flesh…etc.</td>
</tr>
<tr>
<td>Dairy</td>
<td>Butter, fats, water…etc.</td>
</tr>
<tr>
<td>Paints</td>
<td>Colors, oils, toxics…etc.</td>
</tr>
<tr>
<td>Cement</td>
<td>Dust, gases…etc.</td>
</tr>
<tr>
<td>Thermal Power Stations</td>
<td>Waste of power, oil, gases…etc.</td>
</tr>
</tbody>
</table>
3.4 Wastes of Power Stations

3.4.1 Introduction

Typically, oil is burned to heat a boiler that produces steam. Once steam is produced spins a turbine that generates electricity.

Burning oil to produce electricity contributes to air pollution in the Khartoum metropolitan area. Oil burns produces large quantities of the carbon dioxide (CO₂), sulfur dioxide (SO₂), and nitrogen oxides (NO₂) per unit of energy
Oil-fired electricity generators work through burning the crude oil. Crude oil is extracted from oilfields located on land or offshore in the ocean. Crude oil is then converted to more refined products in large oil refineries. One product of this refinement is fuel oil that can be burned in electricity power plants.

Acid rain acidifies the soils and waters where it falls, killing off plants, fish and animals that depend on them.

Global warming is caused by many gases, but carbon dioxide is responsible for at least half of the warming. About 80% of global carbon dioxide emissions come from power plants.

3.4.2 Disposal of Waste Oil in the Nile

Oil spots began to appear in the Blue Nile as minor spots in the early eighties. By 1988 this problem became bigger as the oil spot area produced. Nitrogen oxides exacerbate asthma, reduce lung function, and cause respiratory diseases and premature death.

Smog forms when nitrogen oxides and reactive organic gases combine, especially on warm days. Smog causes crop, forest, and property damage. Sulfur dioxide and nitrogen oxides both combine with water in the atmosphere to create acid rain.

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expanded to reach the intakes of Burri Water Station. At that time the Water was a part of the National Corporation of Electricity and Water, so the directorate of the Electricity Station was contacted and the situation was controlled by thorough monitoring.

After the authorities of Water and Electricity were separated, the problem started to reappear in frequent periods in 2002 as follows:

Each time the oil spots appear they are extinguished by fire hoses; quite a primitive method which does not solve the problem because the oil spots are merely driven off the water station but left floating on the river spreading their hazards all among people, animals and the water environment all along the course of the River Nile.

The Water Station stopped all through the period of existence of the spots causing lack of drinking water to be recovered by other ways.

If the water is pumped by the station it would have been mixed with the oil, which means the probability of causing defects in the machines of the stations and the refining operations, giving out contaminated water\(^{(15)}\).

### 3.4.3 Water Related Aspects of The Law

The Sudanese Constitution of 1988 \(^{(14)}\) stated in section 13: “The State is to work on promoting community health, looking after sports and conserving the environment and its purity and natural balance so generations’ safety and continuous development can be achieved”. The Sudanese constitution also includes many sections related to the subject of conserving water and natural resources. Also the Criminal Act of 1991, section (70) (Contaminating Water Resources) stated: “Whoever exposes the people’s life or safety by putting toxic or harmful substance in a well, a pond or any public source of water is to be imprisoned for not more than three years and may be punished by paying fine as well” \(^{(14)}\).
Also section (71) (Polluting Environment) and section (74) (Carelessness That Causes Danger on People’s Life or Properties).

Khartoum State also made a number of legislations regarding the water safety and purity\(^{(14)}\), for example:-

   - Section 56: Prohibiting Water Polluting;
   - Section 57: Monitoring Drinking Water;
   - Section 58: Conditions of Keeping Water Supply;
   - Chapter 5, sections from 59 to 68.


3. Public Health and Environmental Services Law, section 3 stated:

   “Water polluting means dropping or adding any dirt, garbage, chemical or bacteriological substances to any of the public or private sources of drinking water or to any well or pond and that the manipulation causes or may cause any change on the properties of the drinking water or any harm to the environment.”

4. Environment Protection Law of 2001,

5. Irrigation and Sewerage Law of 1998,


(Reference: \(^{(14)}\)"

And any other acts related to the safety and purity of water.

From all that it is obvious that Sudan does not lack legal legislations related to keeping the water away from contamination, but it lacks practicing and carrying out these legislations. May be it is due to the weakness in the legal environment sense!
The main aim of this legal view is to make these legislations applicable, avoiding unnecessary legal conflicts that the aim of all Sudanese is to keep the environment of Sudan healthy.

3.4.4 Conclusion

It is evident that industrial wastes vary according to the size of different industrial activities, light or heavy, so the industry is evaluated depending on the kinds of raw materials used and the natural resources employed which, ultimately, affects the productivity, in general, positively or negatively.

After production's operations are completed, the wastes remain in the factories instead of being discarded or properly recycled. Industrial wastes lie into three main types; solid, liquid and gaseous. The gaseous wastes either find its way to the air or separated somehow in the industrial unit. These wastes may include chemical toxic substances, harmful substances, organic or even radiant substances. Thus, the directorate of the factory must gather the wastes properly; manually or mechanically, depending on many factors such as cost, kind of waste, labor efficiency…etc. and after gathering the wastes they have to be transported to where they can be, properly, discarded. It can be stored inside the factory but for a certain period of time. Some parts of the wastes can also make some financial benefits if sold, recycled or utilized in a way or another. Outside the factory, the matter needs some coordination with the specialized authorities to discard the industrial wastes using ground, water or air.
Other implications regarding the limits bonding the operation of discarding the industrial wastes are listed below:

1. **Social:**

   Particularly to what extent the people inhabiting the specific area may accept the selected processing and discarding methods. Here, some thorough work and negotiation should be done about the advantages and disadvantages of the selected methods; and if it is accepted that may save a lot of money, otherwise it is much better to think of a way to increase the public participation.

2. **Political:**

   It is the worst especially if it is accompanied with technical and scientific ignorance, which may affect even the best ways. But the political aims and targets are rather fancy and looking towards the horizons other than what we are about.

3. **Technological:**

   Highly influenced by the methods of production, local raw materials, experienced labor and somehow the education level. Among the technology limits we can find cost, compatibility, scientific knowledge and information exchange; and here cooperation is inevitable to raise the technological efficiency by using modern systems benefiting from sciences and experiences.

4. **Environmental:**

   Particularly when there are no wide suitable areas which stop the healthy burial.
Chapter IV

CASE STUDY
TANNING INDUSTRY IN OMDURMAN AREA

4.1 Tanning Industry in Omdurman
4.1.1 Introduction

4.1.1.1 General

The word (tan) and its inflectional form (tanning) which are derived from the Latin word “oak-bark”, were originally applied, still are generally used, to describe the process of converting the putrescible animal skin into the stable product leather, which has satisfied many useful needs of humans since the dawn of civilization. In a wider sense, the term tanning covers in a general way processes in which proteins are stabilized, in industrial as well as biological processes. In the former instance, tanning serves to improve certain properties of the proteins and the substances in order to make them more serviceable in daily life. The biological importance of tanning processes is yet little known and realized, although several instances are known where tanning of proteins is carried out in vivo for securing protection and strength of the organ (3).

Apart from the original use of tanning processes in the manufacture of leather, still the most important, the phenomena of tanning and hardening enter into a number of industries, such as in the manufacture of artificial fibers of proteins or proteinlike materials, the making of photographic film on the basis of gelatin and the making of special glues and adhesives, the preparation of hectograph masses and embalming fluids, and the preservation of sutures (catgut) for the medical profession. Some examples may be given from the biological and medical fields. Some medical preparations rely on their astringency, or tanning power.
The cuticles of insects are made strong and resistant by tanning processes and the wings of butterflies and other insects are hardened and strengthened by crosslinking of the proteins in the chitin-protein framework (3).

4.1.1.2 Definition of Tanning

Leather is collagen in the tanned state. In a practical sense, there is no exact definition of tanning since numerous substances of greatly differing chemical nature can function as tanning agents, and so many different leathers are made, each with its particular use. From the most primitive point of view, leather may ever be defined as skin or hide modified by tanning so as to render it suitable for the intended use.

However, in defining tanning in the more modern, although practical terms, the most sticking physical, directly observable changes involved in the process from the criteria. By tanning, the easily putrescible hide substance is made resistant to microorganisms. Further, leather will resist water and moderate temperature in the moist state, and remain soft and flexible upon drying.

Through the extended knowledge of the tanning process acquired during the last decades, it is now possible to define tanning action in a more scientific manner. The first criterion of tanning potency of a substance is its capacity to form an irreversible combination with collagen, resistant to the action of water. Certain reactive protein groups are inactivated. However, the simple incorporation of an irreversibly fixed agent and the reduction of the water-binding capacity and the swelling tendency of collagen does not constitute of effect tanning. The second criterion is the stabilization of the collagen by the tanning agent, improving its resistance to heat, proteinases, and swelling agents and preventing the “gluing together” of the fibers upon drying (“leatherlike
4.1.1.3 Tanning Agents

Tanneries in the area of Omdurman vary in the usage of tanning agents, but generally these agents may be divided into two main classes (3):

2. Tanning agents of organic nature.

4.1.1.3.1 Basic Tanning Agents

1. Chromium salts.
2. Vegetable tannins.
3. Aldehydes.
4. Certain condensed phenols.

The substances mentioned are the tanning agents of common usage. Chromium salts and natural vegetable tannins being the principal ones.

4.1.2 Tanning Industry in Sudan

In Sudan, tanning industry has started by processing hides into useful leather ready for manufacturing in the production of urgent necessities such as bags, shoes, etc. This industry has well been spread and developed. It shot up to a large scale of 290 classical tanneries in 1988.

This industry - in its modern form – has been started in Sudan after the end of World War II in 1945 as Othman Salih Tannery has been
established together with Diaata Firm for Hides Manufacturing Industry. The government public sector has gone through this industry in 1961 by installing Khartoum Tannery followed by the construction of White Nile Tannery in 1975 and after that ElGeziera Tannery was established in 1977 to suffuse the local markets and to export the surplus (24).

The industry of hides is considered as one of the oldest industries in Sudan (16), as in Omdurman have been constructed about 26 classical (manual) tanneries and are still functioning, but the modern ones that are highly mechanized have been put into action since 1958 and spread widely. There are now about nine of them (24).

**Table (4): Some Tanneries in Sudan** (20)

<table>
<thead>
<tr>
<th>Tannery</th>
<th>Location</th>
<th>Established In</th>
<th>Type of Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khartoum Tannery</td>
<td>Khartoum</td>
<td>1961</td>
<td>Public Sector</td>
</tr>
<tr>
<td>White Nile Tannery</td>
<td>Khartoum</td>
<td>1971</td>
<td>Public Sector</td>
</tr>
<tr>
<td>El-Geziera Tannery</td>
<td>Wad El-Magzoob – Medani</td>
<td>1976</td>
<td>Public Sector</td>
</tr>
<tr>
<td>Afro-Tan Tannery</td>
<td>Elbagier</td>
<td>1984</td>
<td>Private Sector</td>
</tr>
<tr>
<td>Niyala tannery</td>
<td>Nyala</td>
<td>1971</td>
<td>Public Sector</td>
</tr>
<tr>
<td>Salim Tannery</td>
<td>Omdurman</td>
<td>1986</td>
<td>Private Sector</td>
</tr>
<tr>
<td>Gabir Abu El-Eiz Tannery</td>
<td>Khartoum North</td>
<td>1966</td>
<td>Private Sector</td>
</tr>
<tr>
<td>Red Sea Tannery</td>
<td>Port Sudan</td>
<td>1973</td>
<td>Public Sector</td>
</tr>
<tr>
<td>Modern Tannery</td>
<td>Omdurman</td>
<td>1986</td>
<td>Private Sector</td>
</tr>
</tbody>
</table>

The table above reflects the spread in the construction of tanneries within the seventies. All tanneries have been taken into ownership by the private sector by 1994.

Through the years 1961-1967 the scheme of enhancing leather and hides by proper tanning and manufacturing has been adopted by the
Ministry of Animal Resources by the help of the World Food and Agricultural Organization with a special fund from the United Nations Industrial Development Organization (UNIDO), and the Institute of Tanning has been constructed by 1963, which has later been named the National Institute for Leather Technology.

The main aim for this was to enhance and develop the crude hides only, so the government has decided an issue in 1992. By that issue the institute has been connected to the Centre of Researches and Industrial Consultancy when it was annexed under secretarial of Animal Resources. This happened to co-time with the establishment of Khartoum Tannery in 1961. (18) (The Role of the National Centre of the Technology of Hides and Other Training Centers p 3)

The era from (1961-1971) has witnessed a great spread in leather industry whereas a considerable number of tanneries has been constructed (24).

During the eighties, the hides industry deteriorated badly in Sudan and likewise the output deteriorated due to political and economic reasons; e.g.:

1. Nationalization and confiscation.
2. Lack of Basic-Media for such industry.
3. Emigration of qualified technicians.

During the nineties a clear development in both leather industry and products in Sudan has been touched so deeply to an effect that could be felt as Khartoum Tannery -followed by Geziera Tannery- had been scheduled in the private sector ownership (18).
In 1993 a strong issue was announced preventing and stopping the export of hides guiding to use the output of leather towards local manufacturing \(^{18}\).

The issue has advantageously resulted in;

1- Giving wide chances to those who work in tanneries.
2- Real guarantee of having the ready processed material.
3- Having the increased value-added.
4- Benefit from the remains and by-products of leather manufacturing.

The shortcomings can be considered as:-

i. The increasing ratio of the defective and unmanufacturable hides.

ii. The appearance of hides smuggling.

\[^{16} A\ \textit{study into the problem of non-functioning factories and the trial of putting them into function. – p 11}\]

The prevention of hides’ export had negative results, e.g.; the cost increase of tanning led to the increase of local cost which was also reflected on the foreign marketing that became impossible.

4.1.3 Types of Tanneries

There are two types of tanneries in Sudan:

1. The Classical (Manual) Tanneries

Usually found in group forms called (Balladiya Tanneries). They depend upon local stuff of hides. Shortage of manual stuff is
common. They have to be very close to marketing areas. Negatively, classical tanneries have resulted in their **Plate (9): El-Dibagha Quarter and its bad output of hides, a sort that sends out a rottenning smell of hides and materials used for tanning for the absence of chrome, which was real environmental pollution for nearby neighborhoods. The most sufficient example of classical tanneries is found in El-Dibagha Quarter in Omdurman area, North of Abu-Rouf and El-Higra quarters. The study area encloses this quarter, so it **Plate (10): External wall of the tannery conceals the mixed use** of land use. El-Dibagha Quarter is characterized economically by tanning, processing then manufacturing certain bad-conditioned hides which are not exportable and valueless internationally.

2. Modern Highly Technical Tanneries

Those have played an important role in the flourishing of Sudan’s economy as they have been worked in highly technical mechanism and up-to-date methods of tanning long since the late fifties and still spreading. Some of those are characterized by being constructed and installed in areas where there are potential extension areas, enough energy sources and surplus water flow.

They depend greatly on imported tanning chemicals; especially chrome. Employment is highly performed within a mixture of laborers and technicians for working and finishing processes.
4.1.4 Obstacles and Problems of Modern Tanneries in Omdurman

Main obstacles and problems that face modern tanneries in Omdurman area (24):-

i. Lack of tanning chemicals which are imported in hard currency.

ii. Shortages in spare-parts of machines when defected.

iii. The human sector of qualified staff contentedly ran off to the dollar-paying countries.

The majority of modern tanneries in Sudan are mainly found in Khartoum state as it represents the highest consumption area for hides.

Going through the previous information it is clear that the leather industry has been considered as one of the main industries in Sudan. Its importance is being represented in the great benefit obtained from its products at the country’s level together with earning and saving the hard currency.

About 125 slaughterhouses (providers of hides) are available in Sudan scattered all around the different states (24).

Fig.6 illustrates the distribution of classical and modern tanneries in Sudan.

The main reasons for hindering the continuation of construction excess tanneries or reaching the climax of output have always been (16):-

1. Lack of raw materials (hides) and chemicals.
2. Lack of machinery and spare parts.
3. Fluctuation of electricity flow (unsteady).
4. Shortage of qualified staff.
5. Accumulation of debts in Commercial Banks on tanneries (lack of finance).
4.1.5 Tanning Stages:

Tanning industry passes through these stages\(^{(24)}\):

1- Raw hides (wet-slated or dry-slated) are inserted in cleaning barrels or tanks together with dipping in the sodium sulphide solution for removal of hairs (deharing), then mechanically rotated to remove fats and layers of flesh. *Plate (11), (12).*

2- Secondly comes the process of removing the sodium sulphide by adding salt, sulpharic and formic acids. *Plate (13), (14).*

3- Thirdly comes the tanning operation in which chrome sulphates + sodium carbonates are used within a machine to heal cracks and another machine for squeezing to reduce water in the hides. *Plate (15).*

4- In this stage of the retanning process sulphide oils are used with other industrial tanning materials. *Plate (16).*

5- Lastly is the drying and finishing stage. *Plate (17).*
4.1.6 Risks and Hazards of Tanning Industry

As a result of using chemicals in the tanning operation, poisonous gases, such as sulphurous oxides, carbon oxides and nitrogenous oxides, exist in the tannery. These have a harmful effect on the staff; e.g.; resulting in diseases of lungs, (breathing) allergies and all chest inflammations. Likewise vision is liable to be largely affected \(^{(10)}\).

Various types of wounds and cuts in addition to expected fractures in the bones when moving heavy articles are liable to happen.

All these possible injuries are so dreadful to cause the worker a disease if not disabling him/her partially, it can lead to mitigating his/her efficiency of production and his/her proposed age in the tannery, reducing it to 20% and basically affecting the production of the tannery \(^{(25)}\).

So it became a must that a real move should be taken to enhance and care for the society environmental health and well-treat the problem of pollution specially water used in the tanning industry. Chemicals, such as sulphides and chrome, should be lessened and substituted by a new developed technology instead, to reduce these hazards.
Healthcare should be taken care of by real cleanliness and water showering and obliging workers to follow closely health rules.

**Hazards related to tannery workers:**

The leather industry and in particular tanning processes are notorious for their deleterious environmental impacts and occupational health hazards. Work at tanneries involves a series of hazardous processes presented in Table (5).

<table>
<thead>
<tr>
<th>Physical Hazards</th>
<th>Exposure to high noise levels from mechanical equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Callosities on hands caused by continuous strenuous work with hand tools</td>
</tr>
<tr>
<td></td>
<td>Eye stain due to poor illumination in the tannery.</td>
</tr>
<tr>
<td>Chemical Hazards</td>
<td>Skin rashes and dermatoses as a result of exposure to cleaners, solvents, disinfectants, pesticides, leather-processing chemicals etc</td>
</tr>
<tr>
<td></td>
<td>Allergies-contact and systemic-caused by many of the chemicals used in tanneries.</td>
</tr>
<tr>
<td>Biological hazards</td>
<td>Raw hides and skins may be contaminated with a variety of bacteria, molds, yeasts, etc and various diseases (e.g., anthrax, leptospirosis, tetanus, Q-fever, brucellosis, etc.) may be transmitted to tanneries; also, the large quantities of dust produced in buffing operations would normally be contaminated with disease-bearing microorganisms, putrefaction product, etc.</td>
</tr>
<tr>
<td>Ergonomic, psychosocial and organizational</td>
<td>Acute musculoskeletal injuries caused by physical overexertion and awkward posture while moving heavy or bulky loads, in particular bundles of hides, skins and leather.</td>
</tr>
<tr>
<td></td>
<td>Low back pain due to prolonged working in a standing or semi-bending posture</td>
</tr>
<tr>
<td>Accident hazards</td>
<td>Heat stress, in particular when working on warm days in premises lacking good ventilation or air conditioning.</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>floors, while moving heavy loads such as containers of chemicals, bundles or hides, skin, leather, etc.</td>
</tr>
<tr>
<td></td>
<td>Electric shocks caused by contact with defective electric machinery</td>
</tr>
<tr>
<td></td>
<td>Blows and crushing injuries caused by rotating or moving parts of machinery</td>
</tr>
<tr>
<td></td>
<td>Acute poisiong and/or chemical burns by inhalation, ingestion or skin contact with constituents of tanning process liquors, or poisonous gases released during the tanning process (e.g., hydrogen sulfide)</td>
</tr>
<tr>
<td></td>
<td>Burns caused by contact with hot surfaces or splashed of hot solutions</td>
</tr>
<tr>
<td></td>
<td>Cuts and stabs caused by manual or mechanized working tools</td>
</tr>
<tr>
<td></td>
<td>Eye injuries caused by flying particles from rotary buffing machines</td>
</tr>
<tr>
<td></td>
<td>Asphyxiation or poising in confined spaces, in particular during the cleaning of vats or tanning baths</td>
</tr>
</tbody>
</table>

### 4.1.7 Wastes of the Tanning Industry in Omdurman Area

**Wastes resulting from tanneries in Omdurman Industrial Area:**

1. Solid wastes: tattered bits of leather, hair lumps and chemical residue.

2. Gaseous compounds: those resulting from the rottening and gases in tanning operations and fermented solid wastes.

3. Liquid wastes: according to the World Health Organization (WHO) report, the tanning of one ton of hides is expected to produce liquid wastes of about 52m³.

Plates (18), (19) and (20) show some wastes of the mechanical tanning process, while plates (20) to (22) show some wastes and impacts of the classical tanning process.
Plate (18): Liquid wastes of mechanical tanning collected in tankers ready for final disposal to (where?)

Plate (19): Solid wastes of mechanical tanning collected for final disposal to ……?

Plate (20): First stage of classical tanning process (practically). The effect of lime stone spread out polluting the ground around.
Plate (21): Solid wastes of the second stage of classical (manual) tanning process spread out around the tanneries!

Plate (22): Third stage of classical tanning process. The picture shows the tank filled with hides and tanning materials as well as plastic containers and dirt.

Plate (23): Pollution spread and reaching walls of residential area. Such pollution affects humans living psychologically.

Plate (24): Liquid wastes of tanning leak out of tank into the ground and floats over it. Long-Term effects also reflected in underground water.
Plate (25): Primitive materials used in classical tanning help in fly breeding.

Plate (26): Impacts of tanneries are not just reflected on people working and living in the tannery, but also on the innocent and helpless neighbors.

Plate (27): Researcher having voice notes in (bedroom) attached to the tannery.

4.1.8 Environmental Impacts of Leather Production
According to ETPI, 1997/issue #2, leather tanning has been ranked as one of the most polluting activities compared to other manufacturing sector activities. It also has one of the highest toxic intensity per unit of output\(^{(11)}\).

Converting hides into leather is a heavily chemical intensive process utilizing, roughly, 130 chemical materials.

Plate (28): Collected wastes of a tanning stage just before they were poured out on the surrounding area.

The main chemicals used in the various processing stages include sodium sulfide, lime powder, ammonium sulfate, sodium chloride, sulfuric acid, chromium sulfate, sulphonated and sulfated oils, formaldehyde, pigments in addition to dyes and anti-fungus agents\(^{(11)}\).

Plate (29): Flesh and fats are common wastes of the mechanical tanning. Better treatment will certainly eradicate bacterial contamination.
More specifically, The processing stages are: **pretanning** (*soaking, dehairing and liming, fleshing, deliming, washing, bating and degreasing*), **tanning** (pickling, chrome tanning, wet-blue storage, sorting, splitting and shaving), **wet finishing** (wet back, neutralization, retanning, washing, fat liquoring, dyeing and washing), **dry machine process** (sammying/setting, drying, stacking/toggling, shaving, trimming and pressing), and **finishing** (buffing, spraying/coating, drying and glazing/polishing) \(^{(3)}\).

### 4.1.9 Effects of Tanning Industry in Omdurman Area

The effects being reflected upon the area due to tanning industry are classified into the followings:

#### 4.1.9.1 Environmentally

**i. Air pollution**

Chemical reactions take place during the tanning result in the emission of some gaseous wastes that not only affect workers inside the tannery but also the surrounding areas especially the residential ones.

Also the foul odor emitted from the tanning process result in biological as well as social pressures.

**ii. Soil pollution:**

The land (soil) is generally needed as an investment for housing or cultivation; so whenever it has been polluted it will be of no use for both purposes.

Random or rash disposing of tanning materials has been considered as a direct cause for the soil to have a different nature, losing all its characteristics of a soil which will ultimately be reflected upon mankind and bio-life in general.
4.1.9.2 Economically:

The leather industry is made up of several sections (e.g. tanning sector and leather industry) as it helps in the field of widening job opportunities.

The staff working in large tanneries, such as Khartoum, Afrohide, and Gezeira tanneries, range between 200 – 250 laborers \(^{(24)}\), while in medium-size tanneries, such as Samara and Salim tanneries, there is an average of 30 – 60 laborers.

The Sudanese leather exports have reached most world markets. Markets of the European countries are considered to be the main importers for the Sudanese leathers \(^{(24)}\).

About 17 countries out of 34 all, are the Americas (north & south), Europe, Asia and Africa, have all been importing Sudanese leather. For goat-skin leather it is all exported to both European and American countries \(^{(26)}\).

Some affiliated industries are produced from the remains of tanning industry such as the strengthened hides industry, which is made from the remains of hides of cattle, sheep and goats and considered as an alternative for synthetic fibers. They are produced in forms of sheets of different grades of thicknesses, ranging between 1 – 6 millimeters after being mechanically tanned to be used in shoe making \(^{(8)}\).

The annual output can be estimated for most tanneries to be 1200 tons \(^{(26)}\). This yield can suffice the need of small leather industries in the United Kingdom summing in return 4 million dollars yearly for Sudan \(^{(26)}\).
Upon having a general review of the former sections, the economical effects reflected upon the area due to the rise of industries can be summarized in the following points:

1. The direct and indirect costs in treating and curing effects of pollution.
2. Decline of agriculture and animal production due to several factors that pollute soil.
3. The financial increase in treating and purifying drinking water and hygienic drainage water.
4. The cost of expenditure on researches and treatment of sewage.
4.1.9.3 Socially

An important part of the study area, specifically where the classical tanneries are situated (Al-Dibagha Quarter), lies in the midst of the residential areas, north of Abu Rouf Quarter and Higra Quarter, whereas a large number of buildings have been built with primitive building materials (Galoos). Hygienic drainage system that helps solving the problem of the liquid wastes and lessening the environmental problem is lacked in this area. As a result of this shortage of drainage systems, all waste water produced from the classical tanneries is being discharged by direct spilling into the streets and surrounding areas. Due to such attitude various diseases, such as Malaria, diarrheas, respiratory and water-born diseases are widespread. High frequency of fly breeding has been observed in the quarter.

4.1.10 Planning Situation in Omdurman Area

For those who can realize, the planning situations of tanneries in Omdurman area is such hazardous. Concerning the tanneries, both manual and mechanical, the mix-use of land-use represents a critical
environmental problem when considering the overall context (e.g. factories of food, tanneries and residential areas are all in the same block).

Considering Aldibagha Quarter, where the manual tanneries are situated, the mix-use of land-use took place as a result of some economical and social reasons. The need to raise income was the main reason for this mix-use. Difficult economical conditions forced the tanning workers to use their own houses as tanneries subjecting their lives, as well as their families’, to a real jeopardy. Those workers had split their houses into two parts, one part as residential and the other as a tannery. Other workers, who have houses with smaller areas, have the residential and the tanning activities in the same space [refer to plates (26) & (27)]. This mix-use affected not only the residents of the house but also the neighbors as the gaseous wastes and rottening smells transfer easily due to the weak sense of orientation amongst those tanning workers.

Also it was observed that the widths of the internal roads of Aldibagha Quarter are quite narrow. This problem is due to the inefficient planning of the area, if it was already planned.

The area of Omdurman needs quick actions aiming towards solving these critical planning problems.

4.1.11 Solutions and Priorities for Solving Tanneries' Problems in Omdurman Area

A. Replanning of the area to face problems concerned.
B. To build a co-union among the whole units of both modern and classical tanneries health organizations.
C. Strongly guide the staff of tanneries and alert them of the dangers and hazards of environmental pollution caused by the wastes of tanneries.

D. Planning of new industrial areas to skip and improve the existing environmental problems.

E. Training those working in tanneries on the bases of both scientific and practical considerations about the process of tanning and raising their efficiency.

F. Close control of the tanning process and wastes’ disposal methods to make sure that they are compatible with health standards.

G. Employing specialized engineers in the treatment of water drainage for controlling drainage stations.

H. Provision of garbage collection systems.

I. Provision of new drainage systems.
Plate (30): Would these tanning workers have their problems solved?
4.2 Assessment Tools

A worksheet and a questionnaire have been prepared to assess the current environmental situation of the tanning industry in the study area. Results of the two tools would have an assisting role in gaining more environmental information about the study area, upon which the conclusion and recommendations will depend. The questionnaire’s settings were meant to deal with the environmental impacts in the study area as a whole, while the worksheet was meant to handle the tanning’s issue in specific.

Formation of the questionnaire was mainly set to gather information concerning the environmental problems in Khartoum Metropolitan Area. Setting of questions was directed towards having a deep perception about the existing situation of the environmental problems spread in Khartoum Metropolitan Area out of which basic solutions would be obtained.
4.3 Results of the Analysis of the Information

4.3.1 Results of the Questionnaire Study Conducted in Omdurman Industrial Area

In general, the results of questionnaires, which had been used to collect needed information in the industrial areas, are roughly resembled. Results of questionnaires of Omdurman Area will be revealed since Omdurman is the selected area for carrying out the case study.

1. Reason for Availability of the Person Questionnaired

2. Presence of Environmental Problems

3. Environmental Problems in the Environmental Area

4. Sources of the Problems in the Area
5. Industries Distributed in the Area to

6. Presence of Sicknesses Due to Environmental Pollution
7. Percentage of the Sicknesses’ Distribution

8. Sicknesses in the Area

9. Effect of the Industries and their Impacts Upon the Environment and Industries

10. Personal Assessment for Impacts of these Industries
5.1 Conclusions

From to the previous results and analysis one can imagine how critical is the environmental problem that faces Khartoum Metropolitan Area due to the inefficiency of the planning system.

One can take a quick look at the analytical charts in the previous pages just to have an overview of the environmental problem that people in the area feel. Residents and workers of the area are the main affected
entities who really suffer and struggle to continue living their normal lives despite all environmental impacts upon them.

The researcher found that the current distribution of the industries in Khartoum Metropolitan Area has its direct negative impacts upon people in specific and environment in general.

In Khartoum Industrial Area the main environmental impact was the observable noise, followed by improper sewage disposal system and the gaseous wastes of the factories in the area. Although the environmental impacts were, according to the survey, of medium appearance, but it did ease the spread out of many different sicknesses such as the respiratory, dermatology, and internal medicine sicknesses.

While in Khartoum North Industrial Area the main environmental impact was air pollution which is due to the existence of Bahri Thermal Power Station due to its gaseous and thermal emissions. Another source of environmental pollution is Alsamrab industrial liquid wastes’ dump that represents a real tragedy. This dump lies among barns to the south of Alsamrab quarter. Beside the dump there is a big sign of a new residential complex named Nabta!

In Omdurman area, where the case study took place, the tanneries shared an active part in the polluting process.

1. Aldibagha Quarter

The situation of the classical tanneries in Eldibagha Quarter could be summarized in the following paragraphs.

The classical tanning process is a primitive one that has health hazards upon the workers. Among the materials used in the tanning process there are some materials that chemically react when mixed with other materials. In some stages of the classical tanning process the hides need to be neutralized. Sometimes the reaction would not be noticed by
the workers so they do not pay any attention to the hazards in the process. Due to such hazards long-term impacts are affecting workers’ health.

The dual use of the houses in Aldibagha Quarter, as residential and tanneries at the same time, has its direct negative impact on the residents of the house, particularly the children, especially if we realized that the wastes of the tanning process are spread inside the house.

Also it can be noticed the mix-use of land use, where house are so close the tanneries (tangent in most cases). Some negative health and social effects emerged as a result of this mix-use, to the extent many residents left their houses due to the spread of the tanning wastes (liquid, solid or even rotten smells).

Due to the intensive need to water, the classical tanneries are situated beside the Nile (free water source). This location eased the water feed to the tanneries but on the other side it has its adverse effect upon the river itself. Some liquid wastes are being disposed by direct spilling on the surrounding area of the tannery; the Nile gets its big share from these wastes.

Being close to the Nile, the tanneries are also close to the brick-making spots (kamaen). Such location resulted in some sort of cooperation between the two industries. The brick-making spots use the solid wastes of the tanneries as a free fuel and at the same time the tanneries get rid of a big part of the wastes. Both parts benefited from the deal without any respect to the impacts of such action. The mixing of the tanning solid wastes with the other types of fuel when burning leads to the emission of unknown strange gases. Again, the resulting wastes of the burning find its way to the Nile.

Many institutions, basic and secondary schools and colleges which have students from other quarters, are distributed around Aldibagha
Quarter. The point here is that the effects of the pollution extends for those living outside the area. For sure these institutions have their share form the pollution of the area.

It is noticeable that some farms and cattle barns are distributed around the area. Knowing that the wastes are being indiscriminately discarded, theses areas must have been affected, and knowing that the end-user of both the farms and barns is the man so one can realize the environmental effect of the location of this industry.

Environment in general has been affected with the tanning industry and its wastes. The color of the ground, inside and outside the tannery changed to white which indicates the saturation of the soil with the lime wastes of the tanning process. Such effect results in that the soil loses its fertility till it becomes completely unsuitable for cultivation or husbandry.

2. Mechanized (modern) Tanneries

According to the analysis of the worksheets used in the assessment of the situation of the mechanized tanneries, the key environmental impacts associated with leather processing are listed below.

A. Chemicals

Leather processing requires extensive use of chemicals to treat and soften hides. These chemicals are present in the firm’s liquid wastes and can contaminate community water sources if disposed in unsuitable end points. When chemicals are improperly or inefficiently used in production, costs rise and pollution increases. More efficient chemical use can both lower production costs and reduce pollution.

B. Water Use
Leather processing requires water in almost every stage of production, but certain production methods or machinery can lead to overuse. If a well or a water pump is utilized, excessive water use can deplete water sources for future production or community use. Energy costs for pumping, as well as environmental impacts from energy consumption, will also be higher than necessary. Excessive groundwater use may lower the water table and require frequent redrilling of wells. Also, untreated wastewater from processing operations may contain organic wastes which can pollute both local water sources and degrade water quality for downstream communities.

Using water more efficiently guarantees less costly production and ensures against water shortages that could interrupt production. If the enterprise pays by volume for the water it uses, reducing water usage can be expected to provide substantial savings.

C. Workers Health Hazards

Certain working conditions in leather processing—such as exposure to chemicals in the air or in solution baths—can be hazardous to workers. Symptoms can include skin irritations, dizziness and breathing problems. An unhealthy workforce lower productivity, cause excessive absences and contribute to potentially costly mistakes.

Old conventions stand in the way of giving workers proper medical care. They prefer to use conventional remedies instead of modern scientific approaches. The workers are not really aware of the environmental problems that they are facing. Having lived in these conditions, they have adapted to the situation and have very little motivation for change.

D. Odor
Tannery effluent often contains highly odorous waste. Strong smells can affect quality of life around the tannery site and may reduce or destroy community support for further production or expansion. Controlling odor through improved waste treatment techniques, or even recycling, can improve community relations and may reduce costs.

E. Excess waste

Inefficient or poor production methods contribute to excessive waste and costly product loss. Tanneries with low-quality production processes may have to discard or rework an unnecessarily high proportion of product.

Improving production through maintenance and training can save costly reworking, reduce product loss, and thereby save money while reducing environmental problems and damage.

The study demonstrated that there are many environmental problems at the study area, so the hypotheses of the research have been proved, i.e. that these environmental problems have occurred because the industrial areas at the study area were established without sufficient planning considerations. As a result of such situation, a replanning of the area must be take place as a basis of any environmental reorganization.

This has been realized through the clear environmental impacts at the study area, the lack of essential services related to the industrial area (e.g. sewage disposal systems, surface drainage….etc), the relatively high percentage of sicknesses and accidents due to the inadequacy of planning and administration of the industrial plants activities.
5.2 Recommendations

5.2.1. General Recommendations for Khartoum Metropolitan Area

The final recommendations of the study, mainly, include policies for creating environmentally friendly industries. Two main techniques will be covered to illustrate these policies. These two techniques can be used by public authorities, in consultation with general public, to achieve acceptable forms of environmentally friendly industrial development. The first of these is environment impact assessment for industrial projects. The second technique applies to the preparations of plans which indicate the location of sites for industry.

Environment Impact Assessment

Environmental impact assessment is a technique for ensuring that the likely significant effects of new development on the environment are fully understood and taken into account before it is allowed to go ahead. Environmental assessment describes the whole process by which information about the environmental effects of an industrial project is collected, assessed and taken into account by public authorities in reaching a decision on whether the proposed development should go ahead or not.

An environmental statement is a publicly available document setting out the developer's own assessment of the likely environmental
effects of a proposed development, which is prepared and submitted in conjunction with the application for permission for develop. It is important that developers prepare the environmental statements because this obliges them to consider the environmental effects of their proposals while they are being prepared. This means that environmentally compatible technology and mitigation measures can be included in the design of the project, rather than added on afterwards.

While the responsibility for compiling the environmental statement rests with developers, they are expected to consult those with relevant information. Public authorities who have such information in their possession are required to make it available to the developer.

There were several advantages to undertaking environmental impact assessment. For the local authority and other public bodies with environmental responsibilities, environmental impact assessment provides a basis for better decision making. For developers, as warns of damages, the process should draw their attention at an early stage to the environmental effects of their proposals so that they can incorporate remedial measures into their designs and production plans.

The general public's interest in proposed new development is often expressed as concerns about the possibility of unknown or unforeseen effects. Providing a full analysis of the proposal's likely effects an environmental statement can help to allay fears created by lack of information. At the same time it can help to inform the public on the main issues which the public authority will have to consider in reaching a decision on whether to allow or refuse the proposed development. The general public is often a good source of ideas for how an industrial development can be made more environmentally sound. All environmental statements must include a description of the project and a
summary of its likely effects in non-technical language to help the general public understand the full facts of the case.

The procedures outlined above apply to major projects whose likely effects require systematic and detailed assessment. But even where environmental impact assessment is not legally required, environmental effects will always be among the considerations taken into account by public authorities in deciding whether or not to grant permission for industrial development.

**Environmental Appraisal of Development Plans**

Public awareness of environmental issues has increased markedly in recent years. There is now widespread public concern about the quality of towns, cities and countryside and the adverse effects of new industrial development. For this reason public authorities should carry out an environmental appraisal as part of the process of preparing plans. A systematic appraisal requires that the environmental implications of all policies are assessed and this assessment should be included where appropriate in the documents which explain and justify the plan's policies.

In the context of the system for granting permission for development, this is about recognizing that the sum total of decisions about development should not deny future generations the best of today's environment. This means being particularly aware of the impacts of development on the environment which may be irreversible or very difficult to undo. Translated into the preparation of plans for industrial development, these issues need to be reflected in policies and proposals which overall make adequate provision for development and at the same time take account of the need to protect the natural and built environment.

To an increasing degree, new industries require an attractive location (planning) both for their plant and their workers. For this reason
the environmental quality of an area is very important for its economic future. To achieve such goal a policy of replanning of Omdurman Industrial Area and Aldibagha Quarter must be adopted.

Encouragement and economic incentives can go a certain way to securing environmentally sound industries. However, it has been shown that stricter regulations also force the pace of innovation and the adoption of clean industrial practices and technologies. For this reason the environmental appraisal of development plans, affecting the basic location of industry, and the environmental impact assessment of particular projects are both important techniques for contributing to industrial development which respects the environment in particular local areas.

5.2.2 Recommendations Concerning the Tanning Industry in Omdurman Area

In contrast to many other impacts of livestock production, processing is usually point source pollution and therefore easier to quantify and to control.

Regulations are an essential component in dealing with the environmental impact of tanneries. Since it results in most of the pollution of tanning, regulations may limit or prohibit the use of chromium in tanneries. Control of the use of other chemical materials will lead to the reduction of pollutants in waste water. In addition, odor and gaseous emission control may be prescribed.

Zoning of the industrial plants
For small processing units, a policy of encouraging an even geographical distribution is probably the best approach. Similarly to the tanning industry, specific sites should be identified for industrial processing operations. However, zoning is dependent on a functioning infrastructure and adequate enforcement of pollution control regulations.

**Incentives for encouragement of processing tanning by-products**

Use and processing of by-products depends to a great extent on whether there is a market for a given commodity, on the availability of a practical commercial process for converting the animal byproduct into a usable commodity, and on storage facilities for the perishable product and on whether there will be a sufficiently large volume for it to be financially viable. Increasing the prices for water and energy can make the use of these resources more efficient and thus reduce the waste load and emissions. Incentive policies may help to stimulate a market, creating selective advantages for by-product use and waste recovery but, as with public incentives in general, should be of short duration and well-targeted.

5.2.3 **Recommendations for Omdurman Area**

Replanning of Aldibagha Quarter represents the foremost answer to the question of how to rehabilitate this quarter to be environmentally friendly. The replanning policy should pass through certain administrative gates to guarantee the avoidance of certain previous defects.

Considering the manual (classical) tanneries, the replanning action should consider the need for water. In other words, tanneries should be, as possible, located near water sources (wells, pond …etc). Regulations, old
and new, should be applied severely to cope with the problem of discarding wastes in the Nile, the main source of life in Sudan.

Planning of new areas should manage the problems of industrial areas, especially the environmental ones since they involve a vital branch of life as a whole. Also, planning action should consider the problem of mix-use of land use (as in Aldibagha Quarter). In other words, certain policies should be set up to raise income of the tanning laborers (e.g. the provision of new job opportunities). Infrastructure, as well as main networks, should also be of indispensable consideration.

Deficiency of basic systems, such as garbage disposal and drainage systems, should have insightful solutions in order to create an environmentally compatible system.

A master plan which handles the environmental concerns should be set up to cope with the changes of new developments.

For the existing tanneries, in Omdurman Industrial Area, application of environmental regulations should take place, for these regulations are neglected by these tanneries. Setting up new regulations and policies, to enhance and improve existing situation, would also help dropping the environmental problems.

بِسْمِ الَّذِي حَرَّمَ الرَّحْمَٰنَ الرَّحِيمَ

جامعة الخرطوم – كلية الهندسة و العمارَة
قسم العمارة

استبيان عام

أهالي و عمال منطقة ....................

tاريخ: ..................
الإسم: .................................................
السن: .................................................
المؤهل الدراسي: .........................................

1. ما هو سبب ووجودك في هذه المنطقة؟
أ/ سكن ب/ عمل ج/ أسباب أخرى

2. منذ متى و أنت تسكن في هذه المنطقة؟

3. هل تظن أن هناك مشاكل بيئية في هذه المنطقة (تلوث، ضوضاء، رواج غريبة،...)؟
أ/ نعم ب/ لا

4. إذا كانت الإجابة بنعم، أي المشاكل البيئية توجد في المنطقة؟
أ/ تلوث للهواء ب/ ضوضاء ج/ رائحة غريبة د/ تلوث مياه

5. من وجهة نظرك، هذه المشاكل ناتجة عن:
أ/ صناعات بالمنطقة (ما هي؟) ب/ صرف صحي ج/تعامل خاطئ مع البيئة د/ أسباب أخرى ...

6. ما هي الصناعات المنتشرة في المنطقة؟
أ/ ب/ ج/ د/

7. هل توجد حالات مرضية ناتجة عن هذا التلوث البيئي؟
أ/ نعم ب/ لا

8. إذا كانت الإجابة بنعم، هل نسبة انتشار الأمراض عالية؟
أ/ نعم ب/ لا

9. ما هي هذه الأمراض؟
أ/ أمراض تنفسية (ازهار، أنفلونزا،حساسية صدر، ..) ب/ أمراض جلدية
10. ما هو الحل من وجهة نظرك الشخصية؟
أ/ التعويض بإيجاد أماكن بديلة للسكن أو العمل
ب/ إيجاد مناطق أخرى لتلك الصناعات
ج/ فات أوان الحل فقد دمرت البيئة
د/ حلول أخرى مقترحة

11. هل تظن أن لهذه الصناعات وآثارها دوراً في التأثير على البيئة وانتشار الأمراض؟
أ/ نعم  
ب/ لا

12. ما هو تقييمك لأثر هذه الصناعات؟
أ/ أثر واضح جداً  
ب/ أثر متوسط  
ج/ أثر غير ملموس
أي إضافات أخرى

نشكر لكم حسن تعاونكم معنا،

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