

## Risk Assessment for Hydrocarbon Fuel Storage and Handling Facilities at Gaili Area, Khartoum North-Sudan

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## ABSTRACT

This study focused on evaluating the concepts of risk assessment associated with unsafe acts according to hazard identification at Gaili Area, Khartoum North, Sudan. Approaches used in this study; Research tools: Interviews, definite questionnaire & computer program for descriptive statistics – statistical package for social science (SPSS/version 22 – 2014). The study of risk assessment is conducted for workers in fuel terminals at Gaili area and analyzed using environmental health and safety concepts for eight jobs. Risk is associated with Job (driver, electrician, pump attendant, etc.), after hazards to be identified (natural, environmental, technological, biochemical, etc.). Fuel truck drivers at Gaili area showed the most highly risk job. The result showed that 60% of the incidents were caused by the hydrocarbon fuel transport drivers at the study area as the most highly risk job, followed by the electricians being the most affected job by electrical shocks during working hours followed by the pump attendants then welders followed by mechanics; including fatalities, restricted work activities, injuries, first aid and property damage. The study recommended to formulate of temporary committees such as autumn committee is not efficient in solving the problem, HSE steering committee should be a permanent committee to direct the emergency planning according to risk based assessment for identified hazards.

**Key words:** Environment, Fuel Storage, Risk Assessment

### 1. Introduction

Gaili Area – Fuel Terminals, (70 Km) North of Khartoum as the main Investment for Sudan which costs about (7) Billion Dollars including (Khartoum refinery Co-KRC, petrochemicals plant, Gaili fuel terminals, Garri Power Plant) recently Garri free zone is attached to the area [1]. Managing risks for any projects was previously defined as those significant risks that lead to great losses [2], but recently many examples for companies which collapsed entirely because they focused only on those gross risks, lack of awareness and ignore the risks of investment, marketing, media etc.[3]. Risk management & insurance team: the global model is to join the risk and insurance in one team to provide insurance documents operations, projects and contractors [4]. The team is also responsible of the claim for fair compensation in case of happening of any insured risks [5]. The aim of the study to evaluate the existing safety procedures, regulations, polices and accident prevention methods related to the fuel terminal operations, understand the safety problems, potential hazards and associated risks at Gaili Area and study the incidents rates, root causes and affected workers.

### 2. Materials and Methods:

Location of the Gaili fuel terminals and Khartoum refinery was indicated in figure (4), Gaili area geophysical earth map was indicated in plate (1). The study is covering the risk assessment at Gaili fuel terminals to Study the Relation Between:

- Incident Rate and Nature of the Job
- Work Environment and nature of the Job

The Workers/Contractors about (980) at Gaili Area are considered as the research community. Controlled questionnaire was set and distributed to (75) of Workers/Contractors were considered as the Research stratified Sample according to the Nature of job for Eight different jobs including;

- Pump Attendants
- Electricians
- Mechanics
- Drivers
- Welders
- Fitters
- Store Keepers
- Security Guards

Special Conditions were considered while setting the questionnaire to fulfill the study objectives such as; using local language and clear instructions to answer the questions, definite and clear questions, punctual questions, Neutral

questions could be answered without biased. To study the variations between different variables such as the factors related to the health situation for workers, aging, fatigue and the risky jobs, training, job safety analysis, safety precautions and the effect of climatic data such as Ambient Temperature, Wind Speed/direction and Humidity for those who works at open or Confined Space and the Local Regulations/Orders, Insurance Coverage Policy and the Intention of the Company to protect the Public health and Environment.

Research Tools: Interviews, Definite Questionnaire Computer Program for Descriptive Statistics – Statistical Package for Social science (SPSS/version 22 – 2014) - [6]

Risk Concept: Understanding risk is a complex, multidisciplinary endeavor, there are many dimensions, technical, economic, social, political [7], and these dimensions are not universal and are often divergent [8]. WHO defines risk as “the probability of an adverse effect in an organism, system or sub-population caused under specified circumstances by exposure to an agent” [9]. Environmental risk assessment as outlined is a systematic procedure for considering the potential effects of proposed new projects on the surrounding environment [10]

The essential components of risk are knowledge of the environmentally relevant features of the proposed operation [11] (e.g. emissions, effluents, noise) [12] and understanding of the sensitivity of the receiving environment [13]. The scope of the required assessment should be first defined; the impact of various factors (noise, effluents etc.) can then be assessed. [13]Or the process of considering at the planning stages the potential effects of a proposed new project on the surrounding environment. [14].The descriptive statistics were used for data analysis and describing the research community by electing random samples and other subjects could have the same opportunity for election [15].The limiting factors for the questionnaire and interviews, the existing companies at Gaili area are competitors for marketing of fuels and lubricants, so they wouldn't like to know about the Storage, handling facilities, findings in operations and the manpower capabilities. The questionnaire contains Seven categories of questions, the variables are nominated from (X1 – X23) as indicated below:-

**1. Health and Personal Particularities**

- X1 – Age
- X2 – General Health
- X3 – Vision Test
- X4 – Alcohol/drug Abuse
- X5 – Previous Experience
- X6 – Company Commitment for Safety Regulations

**2. Nature of Job**

- X7 – Fatigue During working Hours
- X8 – Exposure to Petroleum Vapors
- X9 – Exposure to Petroleum Fires
- X10 – Exposure to Electrical shock during working hours
- X11– Exposure to Noise pollution during working hours

**3. Training**

- X12 – Training on Job
- X13 – Safety Training
- X14 – Contingency training and Fire Drills
- X15 – Safety Tools and (PPE)

**4. Work Environment**

- X16 – Effect of Temperature Rise on Job Performance
- X17 – Effect of Humidity Rise on Job Performance
- X18 – Effect of Wind and sand storms on Job Performance
- X19- Effect of Rain Fall on Job Performance

**5. Incident Rate according to incident type**

- X20 – First Aid Injuries
  - X21- Lost Time Injury (LTI)
  - X22- Incidents causing damage more than (50,000) SD. G.
  - X23 – Fatalities or restricted work activity
- Incident Rate according to affected body organs
- X24 – Neck to head
  - X25 – Upper extremity
  - X26 – Trunk front
  - X27 – Back
  - X28 – Lower extremity
  - X29 – Other body parts

**6. Incidents causes for drivers**

- X30 – unknown reasons
- X31 – Traffic violation/ ignoring traffic rules
- X32 – Faulty Action/ reckless driving
- X33 – Mechanical failure
- X34 – Speeding
- X35 - Unsafe overtaking/ turning
- X36 – Unsafe parking/ reverse
- X37 – Delayed perception/ driving distractions
- X38 – Wrong Lane/ Signal
- X39 - Driving a poorly maintained vehicles/ problem in vehicle

**3. Results**

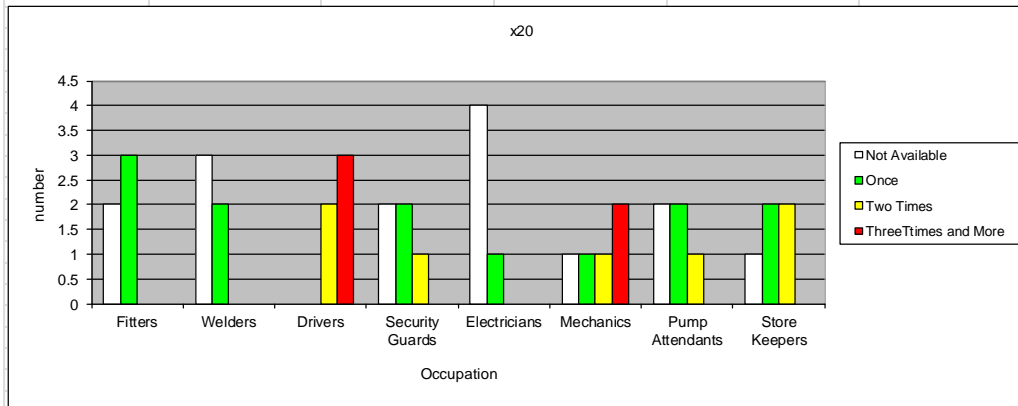
The result of the Study It was found that 60% of the incidents were caused by the hydrocarbon fuel transport drivers at Gaili area as the most highly risk job, followed by the electricians being the most affected job by electrical shocks during working hours followed by the pump attendants then welders followed by mechanics; including fatalities, restricted work activities, injuries, first aid and property damage.

The incident causes for drivers, showed that 34.09% problem in vehicle/ driving a poorly maintained vehicles, 14.57% wrong lane/ signal, 13.83% delayed perception/ driving distractions, 9.10% speeding, 8.28% unsafe overtaking/ turning, 8.42% mechanical failure, 4.38% unsafe parking / reverse, 2.96% faulty action/ reckless driving, 2.59% unknown reasons and 1.78% traffic violation/ ignoring traffic rules.

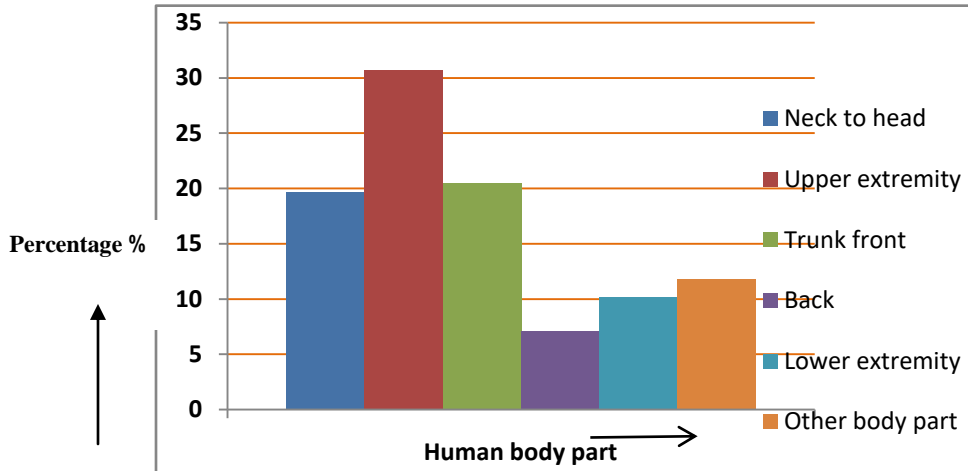
the rate of incidents according to body organs showed the following results; 31.7% for upper extremity, 20.5% trunk front, 19.7% neck to head, 11.8% other body parts, 10.2 % lower extremity and 6.1% for back.

**Table (1) Jobs versus Incidents Rate:**

	Not Available	Once	Two Times	ThreeTimes and More	Total
Fitters	2	3			5
Welders	3	2			5
Drivers			2	3	5
Security Guards	2	2	1		5
Electricians	4	1			5
Mechanics	1	1	1	2	5
Pump Attendants	2	2	1		5
Store Keepers	1	2	2		5
<b>Total</b>	<b>15</b>	<b>13</b>	<b>7</b>	<b>5</b>	<b>40</b>



**Fig (1) for accidents according to body organs**



**Accidents for body organs  
Percentage**

Upper extremity 31.7 %  
 Trunk front 19.7 %  
 Neck to head 19.5 %  
 Other body parts 12.28 %  
 Lower proximity 9.2 %  
 Back 7.1 %

**Fig. (2) Incidents rate per body parts**

**Table (2) Vehicle Accidents Causes**

Vehicle Accidents Causes	Percentage
Problem in vehicle	34.09
Wrong lane/ Signal	14.57
Delayed perception/distractions	13.83
Speeding	9.1
Mechanical failure	8.42
Unsafe overtaking/ Turning	8.28
Unsafe Parking/ reverse	4.38
Reckless driving	2.96
Unknown reasons	2.59
Traffic violation	1.78

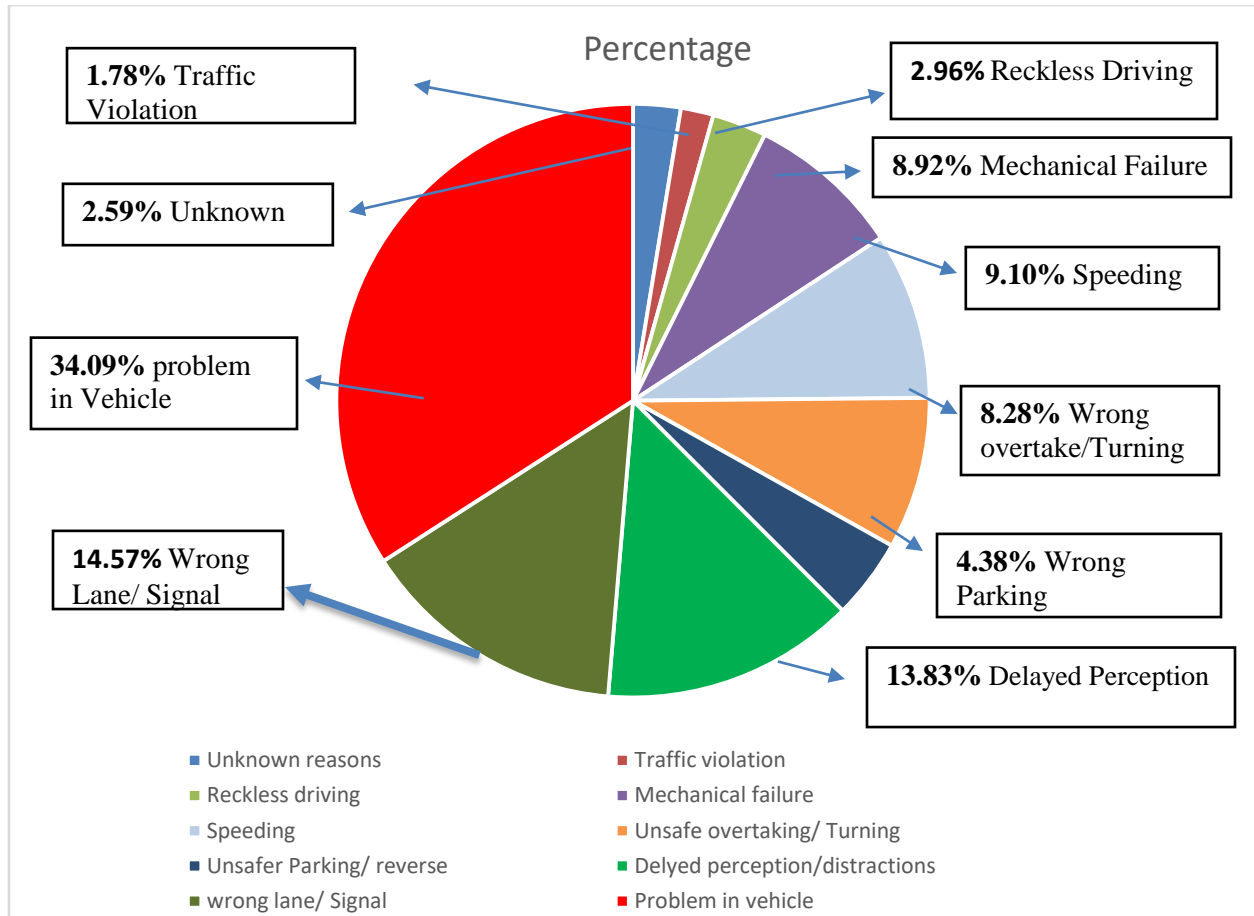


Fig. (3) Vehicle Accidents Causes

#### **4. Conclusion**

No safety records, statistics or incidents documentation system. The lack of official safety data and records of accidents at sites makes safety the last issue to be concerned by contractors and owners. Extensive use of casual / temporary labors: Most small firms use temporary labors, may not assure continuity of work, they were untrained, unskilled and inexperienced, so investing money in training and equipment considered an unnecessary cost,

#### **5. Recommendations**

The formulation of temporary committees in Khartoum State government such as autumn committee is not efficient in solving the problem, HSE steering committee should be a permanent committee to direct the Emergency planning according to risk based assessment for identified hazards. It is recommended to manage safety issues by centralized safety center demonstrated by HSESC, which act as liaison between governmental authorities and fuel distribution companies. The main purpose of such proposed center are to develop and establish unified HSE standards, work as accident data bank, provide training especially defensive driving course for fuel transporters technical consultancy and inspection services. The flame resistant clothing – FRC provides a barrier between a heat source, the skin and increase the chance of survival in the event of flash fire. FRC is recommended in the areas where possibility of flammable material releases of open flame source also when working on live electrical systems that operate more than 220 volts. FRC is the last line of defense against burn injuries

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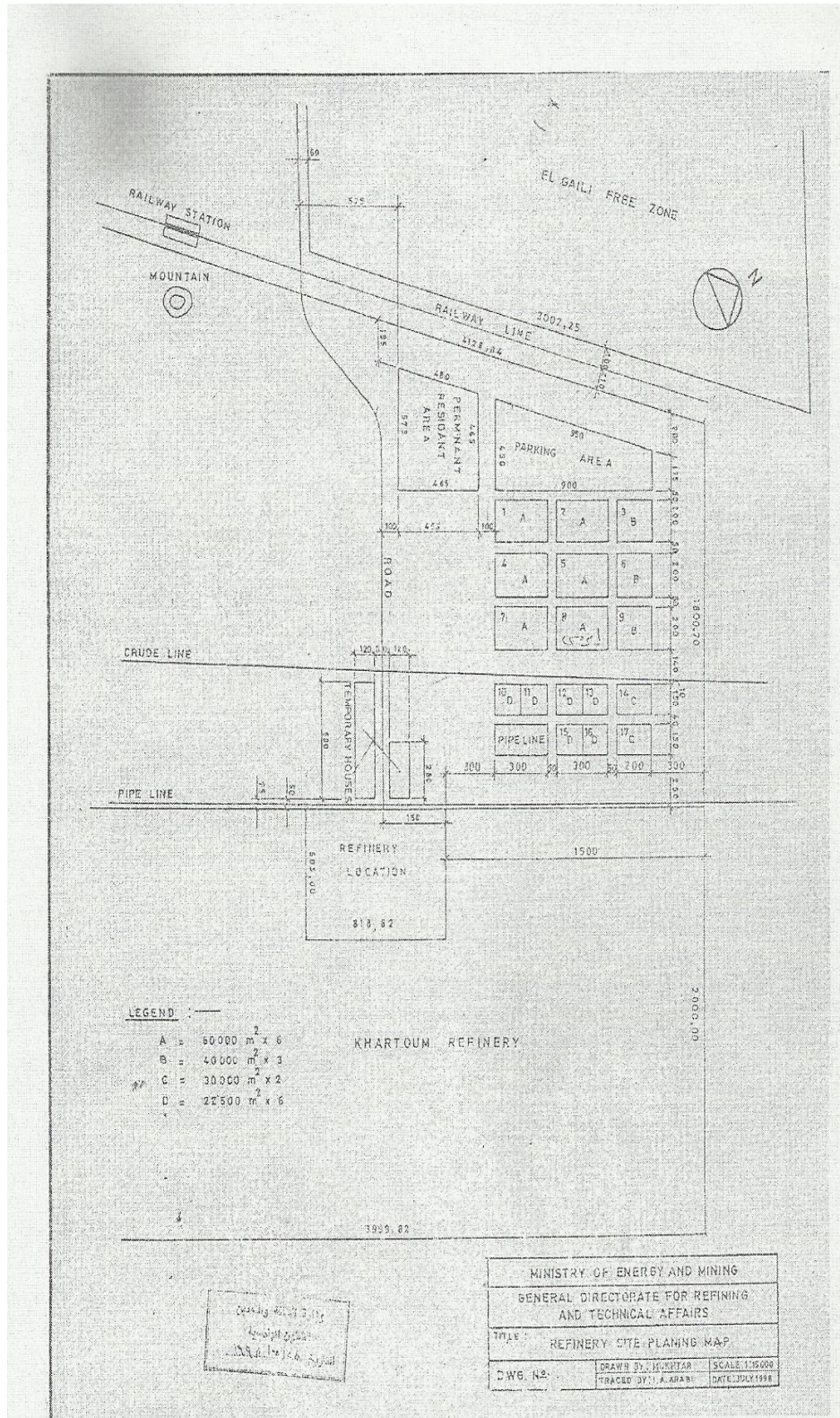
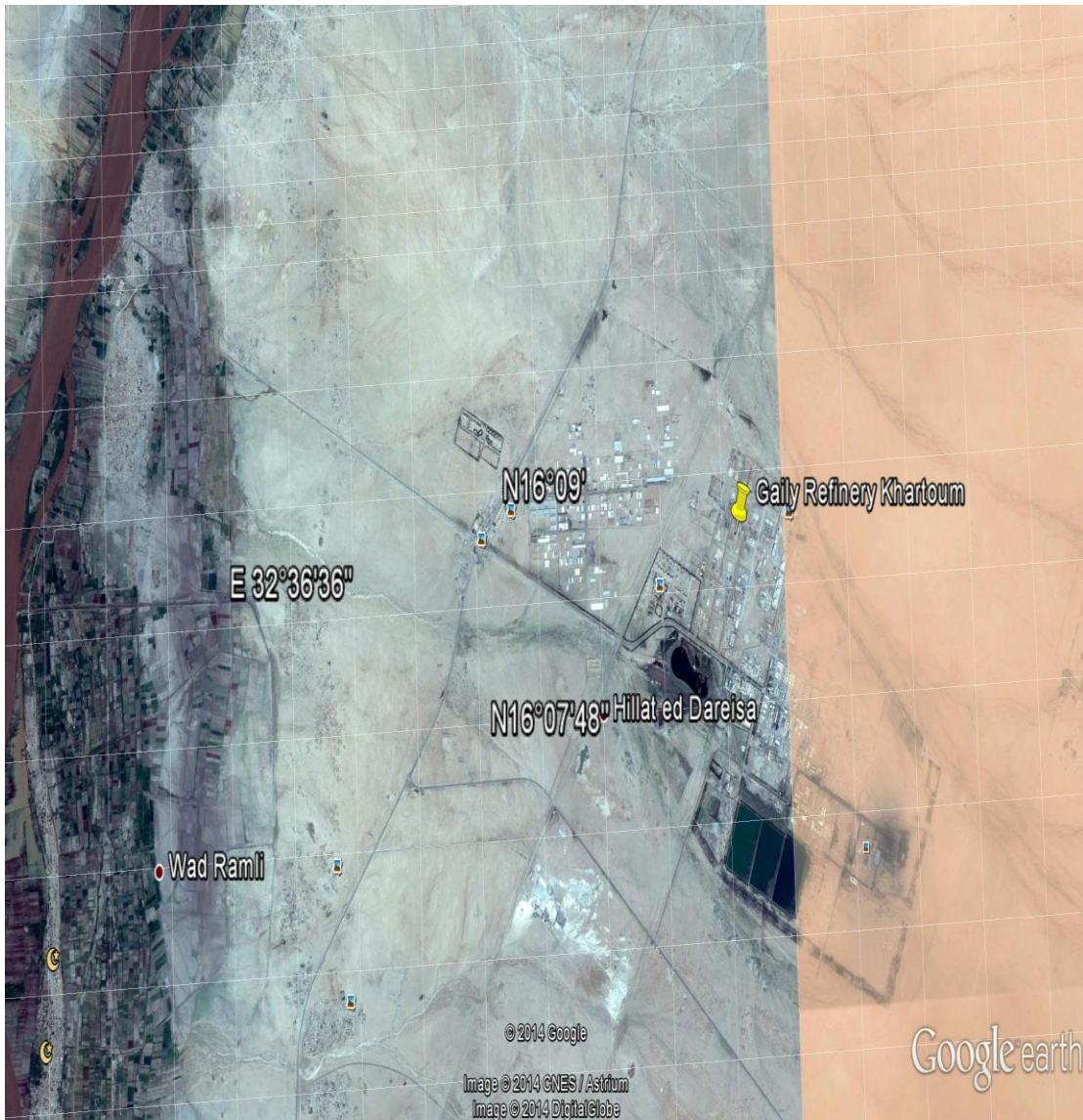


Figure (4) Gaili Fuel Terminals and Khartoum Refinery





**Plate (1) Gaili Area Geophysical Earth Map (on January 2018)**