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Seasonally Waterlogged North of Khartoum North Urban Neighborhoods

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ABSTRACT:

This research conducted in Northern Khartoum North-Elsamrab and Eldoroshab Neighborhoods. Secondary data from published sources and primary information from Geographic Information System and Remote Sensing images together with field surveys (case study) findings, used to identify factors thought to be contributing to seasonal waterlogging in the area. The Soil Conservation Services-Curve Number (SCS-CN) method used to estimate the direct runoff depth and the consequent volume of specific rain event for planning and control purposes. The research concluded that, the on ground conditions, observed facts and real-life truths in the area denote inability of the existing control procedures and measures to efficiently reduce and/or convey runoff flows to a final destination, whether it be, the atmosphere, groundwater or receiving waters. The main result figured in this study is a forest strip proposed for runoff conservation as part of an effective overall drainage network system.

KeyWords: Geographic Information System, Measures, Proceures, Remote Sensing, Runoff, Soil Conservation Services-Curve Number (SCS-CN), Waterlogging.

1- INTRODUCTION

Rapid urban growth is a worrisome global urban challenge [1]. In developing countries including Sudan, people rush towards urban centers fleeing natural and manmade hazards seeking safety and economic opportunities due to political instability and lack of rural development. The major impact of the phenomenon is the unplanned urban spreading that brought forth serious urban challenges such as service providing, environmental decline and flooding problems. The motive for this paper is to get hold of what behind the seasonal waterlogging in the area that recurrently results in life and property losses, injuries,

environmental degradation, health risks and life disturbance. The area commonly subjects to flash and surface floods from remote sources and/or anywhere rainwater collects within it.

The waterlogging problem is stressing enough to evoke researches to take an interest in the issue. Thus, this paper is one that meant to take such an interest, aiming to reduce the impact of floods on the urban settlement through identifying the causative agents and to appropriate a planning vision for runoff conservation and control. The methodology followed is to discuss and analyze agents creating the problem using data gained from GIS images, statutory arrangements, observations, and modelling techniques.

The research concluded with a planning vision for conservation and control of runoff incorporating utilization of natural processes and an overall catchment control system, emphasizing restoration of catchment ideality and enforcement of statutory and regulatory measures ahead of looking for a solution.

2- FIELDWORK (Case Study)

A fieldwork performed in the context of this research paper, covering the area of Elsamrab and Elduroshab neighborhoods, north of Khartoum North district, Fig. (1).

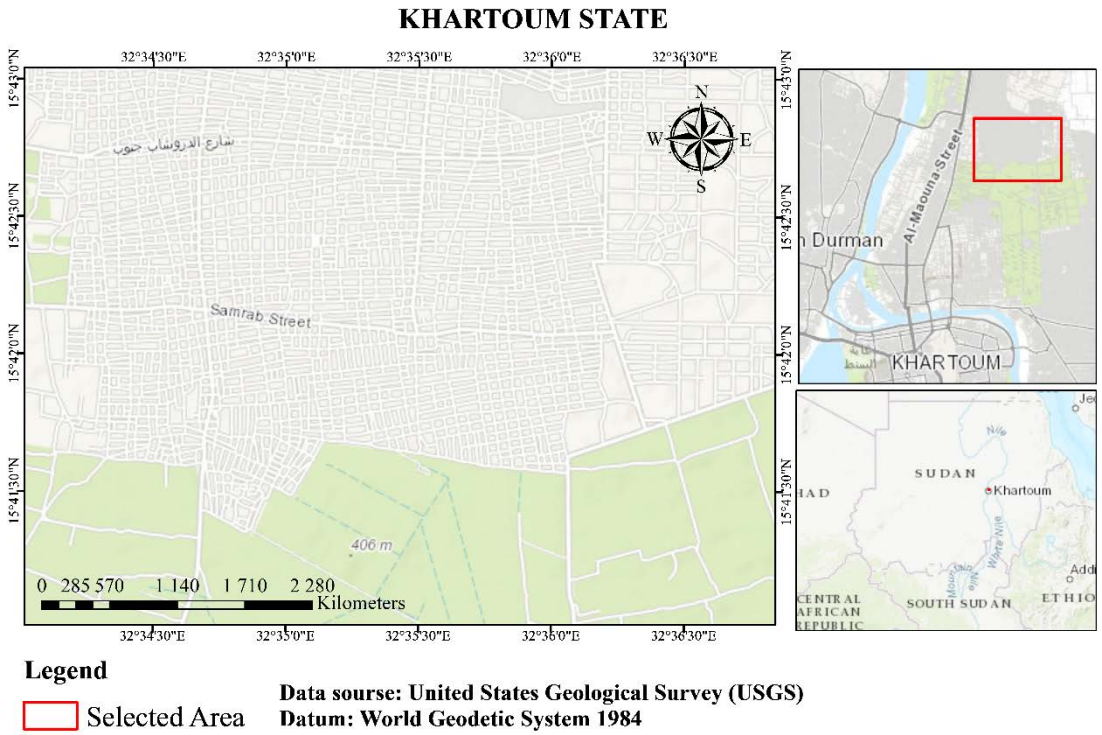

Fig. (1). Study area

The study aims to identify and analyze factors thought to be contributing to the risk

of flooding in the area and estimate the direct runoff volume produced on Block 9, Elsamrab, the southeast most of the study area. The following natural, technical and legislative factors of the area examined in this context:

2.1Topography

The natural topography of the area is flat land at a height of 378 m at the middle, sloping smoothly to the north and northwestern at northern extensions, and to the south and southwestern at south extensions where levels descended to 374 and 372 m, Fig. (2) and Fig. (3). This topographic nature is good for rainwater drainage, the problem observed to be firstly exists in the random made-up street topography due to uncontrolled development activities and accumulation of solid garbage that thwart runoff flow in the area.

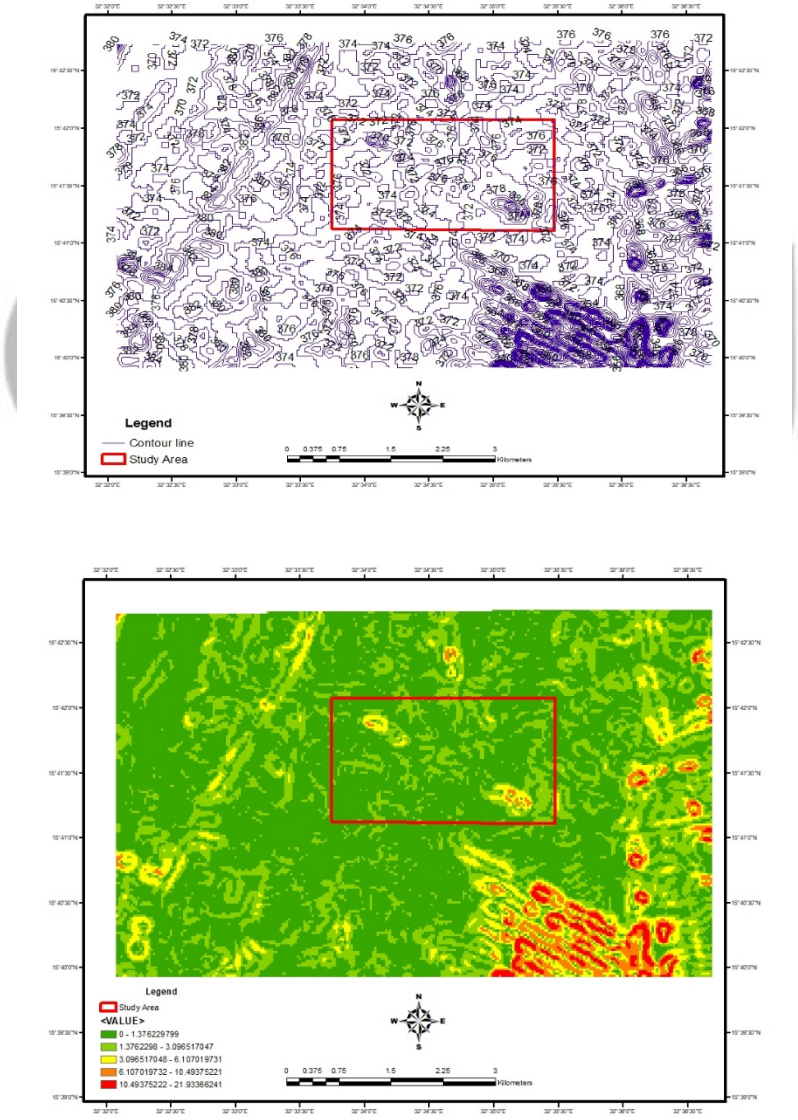

Fig. (2). Topographic images for study area and modelling zone.

2.2 Natural Streams

The nature of natural streams is taking dendritic pattern of short lengths that originate and end-up within the area without extending directly into the Nile; they thought to be resulted from erosion of land surface. These disconnected to water body dendritic streams constitute no threat in the area. Fig. (3).

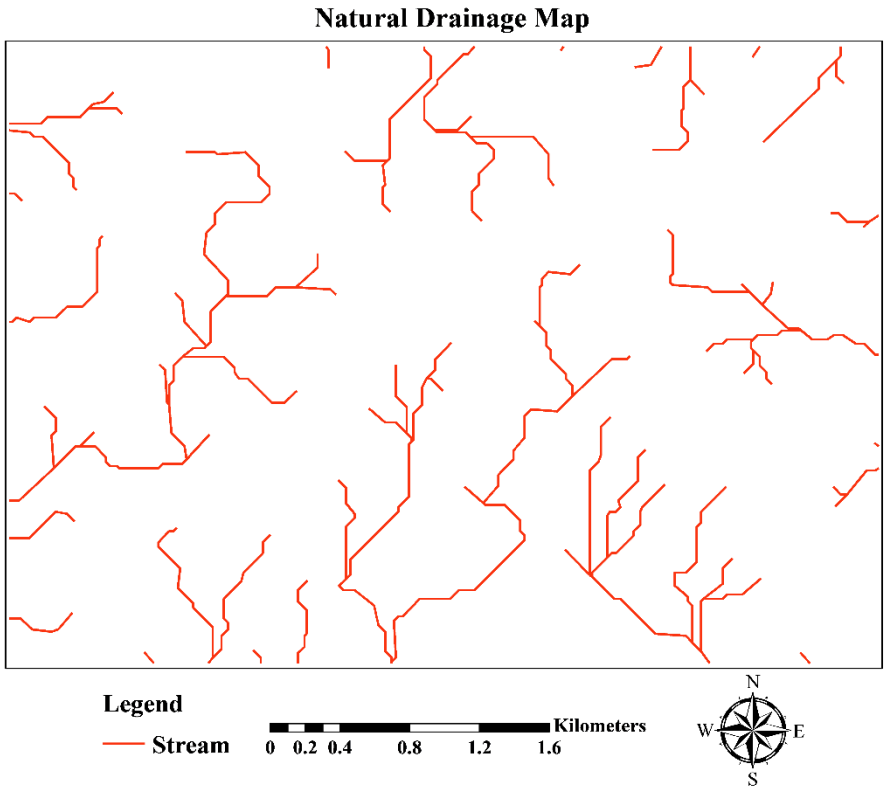

Fig. (3) Natural drainage image.

2.3 Flood prone zones:

No low lands encountered in the area, only obstructed water flow and insufficient drainage facilities that cause surface flooding.

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2.4 Land use

The spatial planning in the area features residential buildings and streets with very limited number of playgrounds and free of components such as squares, community parks, pocket parks, green areas and buffers that are important to runoff control. The impact of urban planning on runoff drainage manifest in flow impediments such as overreaching the right- of- way, and violations and abuse of public streets by residents and urban service providing institutions. The existing runoff drainage facility in the area consists of very limited, almost earth drains, just along macadamized streets leading to Elduroshab amid outlet into the River Nile, and are always failing to serve even the catchment area of streets along which they are extending due to surface imperfectness , lots of impediments, non-designed vessels and lack of follow up.

2.5 Statutory and regulatory controls

The building regulation and urban growth control bylaws in Khartoum State are good and quite enough to guarantee perfect catchment conditions, the problem exist in the historical lack of follow up and enforcement of them, [2].

2.6 Runoff control strategies

No strategies even for runoff drainage apart from control [3] and [4].

2.7 Model application for runoff estimate

The study also aims at estimation of the direct runoff volume produced by the catchment area of Block 9, Elsamrab for runoff planning, conservation and control purposes, using the SCS-CN (Soil Conservation Service-Curve Number) model, [3], [4] and [5]. The area was historically part of Elsilate agricultural project of clayey expansive soils. Rainfall intensity obtained from Sudan Meteorological Authority (Shambat gage station), table (1). A maximum rainfall intensity of (147.5mm) for 04-Augusut-1988 rain event chosen to estimate the direct runoff depth. According to images produced in the course of performing the simulation of rainfall-runoff process in Khartoum State [6], hydrologic soil group map and land use map overlaid and curve numbers determined for estimation of runoff depth. The current research study area is a part of the simulation area and found to be covered by soil group D which corresponds to urban and associated area land use of curve number CN = 95.

Table (1) Maximum rainfall events and resultant monthly and yearly total amounts for the period 1988 to 2020.

Date	Max. rainfall intensity mm	Total monthly rainfall	Total yearly rainfall
04-Aug-88	147.5	229.9	446.9
09-Aug-13	44.0	99.9	143.0

25-Jul-14	88.0	136.5	242.5
14-Aug-18	67.0	127.6	220.5

Modelling results:

Running equations: $Q = (P- 0.2S)^2 / (P + 0.8S)$

$CN = 25400 / 254+S$

Values of S and Q found to be as:

S = 13.4

Q = 132.6 mm

Using the study area that found to be of approximately (1250000) square meters, the resultant runoff volume produced by the rain event of (147.5 mm) intensity, the most intensive in thirty two years, on the specified watershed that need to be planned and managed is obtained as:

V = QA, which amounted for (165750) cubic meters.

3- RESULTS AND DISCUSSION

GIS images showed suitable topography for efficient surface drainage with no threat by the dendritic natural streams over the area and no flood prone zones encountered. The land use pattern is lacking urban components crucial to runoff reduction. Hence, all natural factors that thought to be contributing to the risk of flooding in the area, mainly, topography, natural streams and low lands proved irresponsible for flooding occurrence. According to field surveys and observation, the problem found to be exists in factors attributed to the adopted urban planning method and related roles.

The study concluded that, the area is undergoing lack of any form of effective drainage network system coupled with imperfectness of surface conditions and countless runoff flow impediments that thwart runoff movement and drainage, resulting from uncontrolled development and service providing activities due to official slackening in enforcement of statutory and regulatory measures and controls. Green features that can effectively share runoff control are in complete absence, too. The on ground conditions, observed facts and real-life truths in the area denote incapability of the existing control procedures and measures to efficiently reduce and/or convey runoff flows to a final destination, whether it be, the atmosphere, groundwater or receiving waters.

The study recommended that, the amount of runoff produced, preferably planned to irrigate a nearby forestland or green buffer parting between this residential area and the southerly abutting current agricultural lands to benefit; parting value, restore a green element into the urban landscape, recharge ground water, provide leisure time and

recreation resort, and add income generating opportunities [7] and [8]. The overflow, if any, may then discharged through a cost effective drain into the drainage network that required to constitute part of an overall drainage network system for the whole area. According to observation and topographical images, the part of the area, lying southerly along Elsamrab Street, may drain through East-West minor drains to discharge into North-South intermediate drains. Which in turn discharge into a major drain at the southernmost periphery of the area, extending East-West through Elhafaia pluvial to discharge into Al-Engaz Street storm tunnel to lead to Eldoroshab amid outlet into the River Nile, [9]. The same approach applies to the part of the area lying northerly along Samrab Street that sloping to North and Northwestern through major drains leading to Eldoroshab amid and Khor Eldoroshab outlets into the River Nile, [9]. Above all, bearing in mind that, catchment conditions are far from ideal, restoration of ideality is a crucial prerequisite before thinking of which or which.

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