ORDERED LOGIT REGRESSION MODEL FOR PREDICTING MAGNITUDE OF FLOOD ALONG FOMA RIVER KWARA NIGERIA

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Abstrak

Banjir adalah bencana alam yang menjadi kebimbangan besar kepada kerajaan Nigeria. Meskipun terdapat pelbagai bahaya yang berlaku disebabkan oleh banjir, hanya sedikit perhatian diberikan dalam menilai bahaya banjir melalui keadaan sungai dan komponen-komponen berbahaya di sepanjang kawasan sungai. Oleh itu, kajian ini memeriksa keadaan sungai dan komponen-komponen terdedah kepada bahaya banjir di sekitar kawasan sungai untuk menentukan pembolehubah rentas lintang yang meramalkan magnitud banjir di sepanjang kawasan Sungai Foma. Data yang telah diekstrak dari Sistem Maklumat Geografi (*GIS*) dan pemerhatian di lokasi digunakan untuk menghasilkan pembolehubah rentas lintang di sepanjang kawasan sungai. Dari set data, lapan pembolehubah rentas lintang telah diperolehi bersama 530 struktur di Sungai Foma. Model Regresi Logit Tersusun (*OLR*) telah dibangunkan untuk meramal magnitud banjir. Model dinilai dengan menggunakan nilai purata ketepatan, ketepatan terperinci, ingatan semula (*recall*) dan skor-F1 yang telah diperolehi dari prosedur tatacara 10-lipatan pengesahan bersilang. Skor-F1 tersebut mampu untuk mengharmonikan dan mengurangkan ralat dalam mengawal taburan kelas yang tidak seimbang. Dapatan kajian juga mendedahkan bahawa kawasan aliran sungai, status struktur binaan, struktur binaan yang terdedah kepada banjir di sepanjang sungai, lokasi jambatan dan pembentung, ukuran jambatan dan pembentung dan pencemaran sungai mempunyai kesan ketara ke atas magnitud banjir di sepanjang Sungai Foma. Kajian ini menghasilkan pendekatan pelengkap kepada ramalan banjir di sepanjang Sungai Foma, serta menyediakan kerajaan Nigeria dan juga kepada para pengamal satu sumber maklumat baru dalam menangani masalah berkaitan banjir sungai di Nigeria.

Kata kunci: bahaya banjir, kajian rentas-lintang, peramalan magnitd banjir, pengesahan silang, Model Regrasi Logit Tersusun

Abstract

Flood is a natural disaster that has become a major concern to the Nigerian government. Despite the numerous hazards caused by the flood, little attention has been directed towards evaluating the flood hazards through the river condition and vulnerability components along the river areas. Hence, this study examines the river condition and vulnerability components to determine the cross-sectional variables in predicting the magnitude of flood along Foma River areas. Data extracted from Geographic Information System (GIS) and site observations were used in generating the cross-sectional variables along the river areas. From the dataset, eight cross-sectional variables were obtained including 530 structures of Foma River. The Ordered Logit Regression (OLR) Models were built to predict the magnitude of flood. The model was evaluated using average values of accuracy, precision, recall, and F1-score which were derived from the 10-fold cross validation procedure. The F1-score was able to harmonize and reduce the errors in regulating the imbalanced class distributions. It was also revealed that river watersheds, structure vulnerable status, vulnerable structures along the river, locations of bridges and culverts, sizes occupied by bridges and culverts, and river pollution are significantly contributing to the magnitude of the flood along the Foma River. This study produced a complementary approach to flood prediction along the Foma River, as well as provided the Nigerian government and practitioners a new source of information in addressing problems related to river flooding in Nigeria.

Keywords: flood hazard, cross-sectional study, prediction flood magnitude, cross validation, Order Logit Regression Model

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List of Abbreviations

ArcGIS: Aeronautical Reconnaissance Coverage Geographic Information System

GHS: Green House Gases

GNU: Used to denote a general public license which stands for GNU's not

UNIX. Is a UNIX like computer operating system, free and contain no UNIX code.

Gretl: It is a girl name in Greek origin, with the meaning 'Pearl'. A Gnu Regression, Econometrics and Time-series package named Gretl.

IPCC: Intergovernmental Panel on Climate Change

IPCC TAR: The Intergovernmental Panel on Climate Change Third Assess Report

NIMET: Nigerian Meteorological Agency

NOS: National Ocean Service

NPC: National Population Commission

SRTM: Satellite Imagery and Shuttle Rader Topography Mission

SPI: Standard Precipitation Index

UNEP: United Nations Environment Program

UNISDR: United Nations International Strategy for Disaster Reduction

WMO: World Meteorological Organization

List of Publications

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Chindo, A. A., Shaharanee, I.N.M. and Jamil, J.M. (2019). A conceptual Framework for Predicting the Effects of Encroachment on Magnitude of Flood in Foma-river area. kwara state, Nigeria using data mining techniques. Test Engineering and Management, Published by; The Mattingley Publishing Co, inc. http://testmagzine.biz/index.php/testmagzine/article/view/520/471

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Over the last 20 years, our environment has been changing steadily due to human activities and natural disasters. An observable alteration in the atmospheric condition of the earth's surface becomes an increasingly high-profile issue both from the social and economic viewpoints (Mandea, Korte, Yau, & Petrovsky, 2019). River flooding affects many people globally compared to any other disasters. According to the global assessment report on disaster risk reduction, the yearly average loss of the entire world is estimated at around 104 billion United States Dollars (UNISDR, 2015). Due to growth in the economy and climate change activities, the loss is expected to further increase. Thus, these losses resulting from the increasing magnitude of flood can be attributed to climate warming (IPCC, Special Report of Working Group I and II, Cambridge Univ, Press, 2012).

Floods are among the most periodic and overwhelming natural hazards, which tend to impact human lives and results in severe economic damage across the world. The underlining climate change tends to threaten the entire world (Jonkman & Dawson, 2012). However, evaluating flood has been hindered by several complications, including inaccurate data, poor assessment of drainage basin, pollution, and encroachment (Hall, Arheimer, Borga, Brázdil, Claps, Kiss, & Llasat, 2014). A way to avoid these complications can be the use of cross-sectional data to determine the prevalence of the magnitude of the flood rather than its incidence (Peck, 2019).

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Appendix A
Location's Coordinate Points and Drainage Parameters

Table 1.1

Coordinate Points and Drainage Densities

Points	GPS Coordinates Points		Drainage Parameters		Locations
	EAST	NORTH	WIDTH	DEPT	CAIS
1	664870	937846	3.0m	0.7m	Opposite ALHIKMA
2	665603	938285	3.0m	0.7m	Okefoma estate
3	665951	938737	8.5m	1.75m	Okefoma main bridge
4	666247	939511	6.0m	2.5m	Oloje estate
5	666499	940491	3.0m	1.5m	AjetumabiOwode
6	666714	941184	6.2m	1.8m	Oloje/ okoolowo bridge
7	668296	942167	8.0m	0.9m	FomaBabalaje
8	669612	943122	13.5m	4.5m	Alagbado new bridge
9	670948	943051	7.8m	2.5m	Sobi / Shao bridge

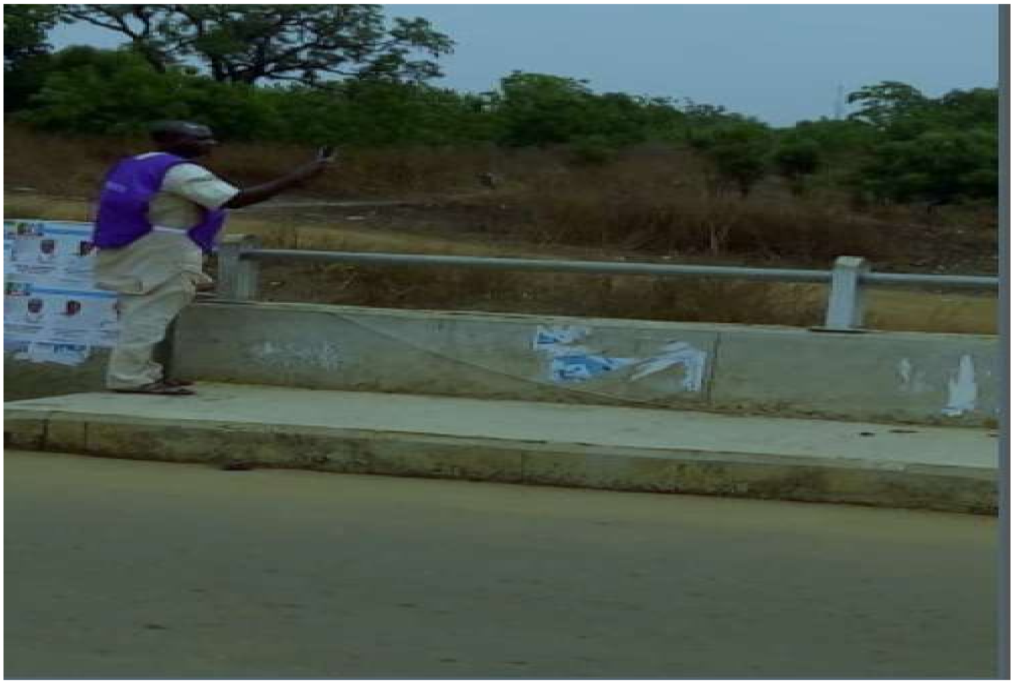

*Figure 1.1:*Obtaining the Drainage Parameters on Site

*Figure 1.2:*Taking the Coordinate Points on Site

Appendix B
Google Imageries and The Watersheds

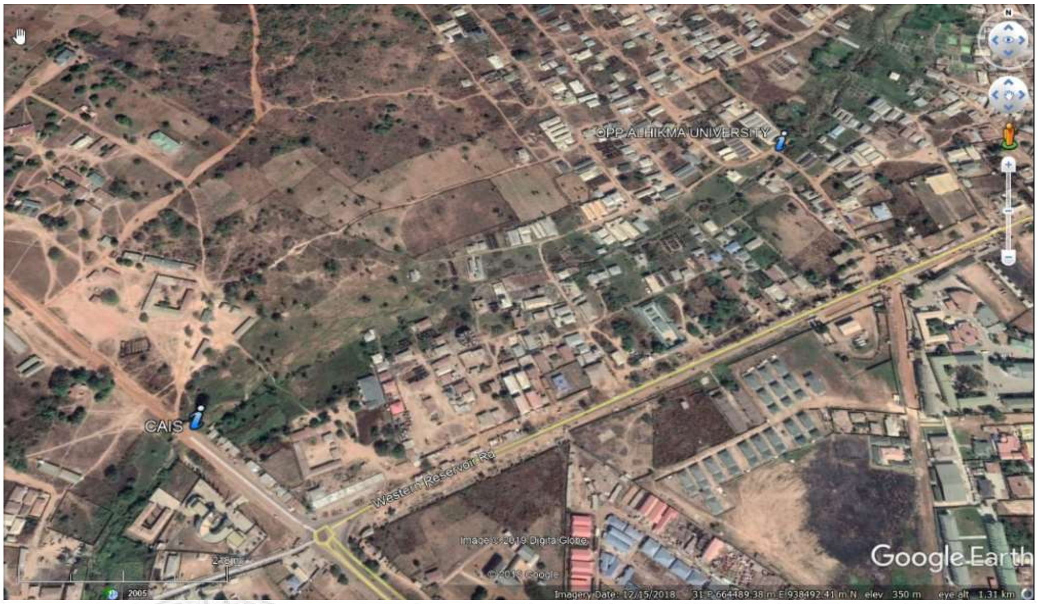

Figure 2.1: Google Imagery of the Source of the River along CAIS

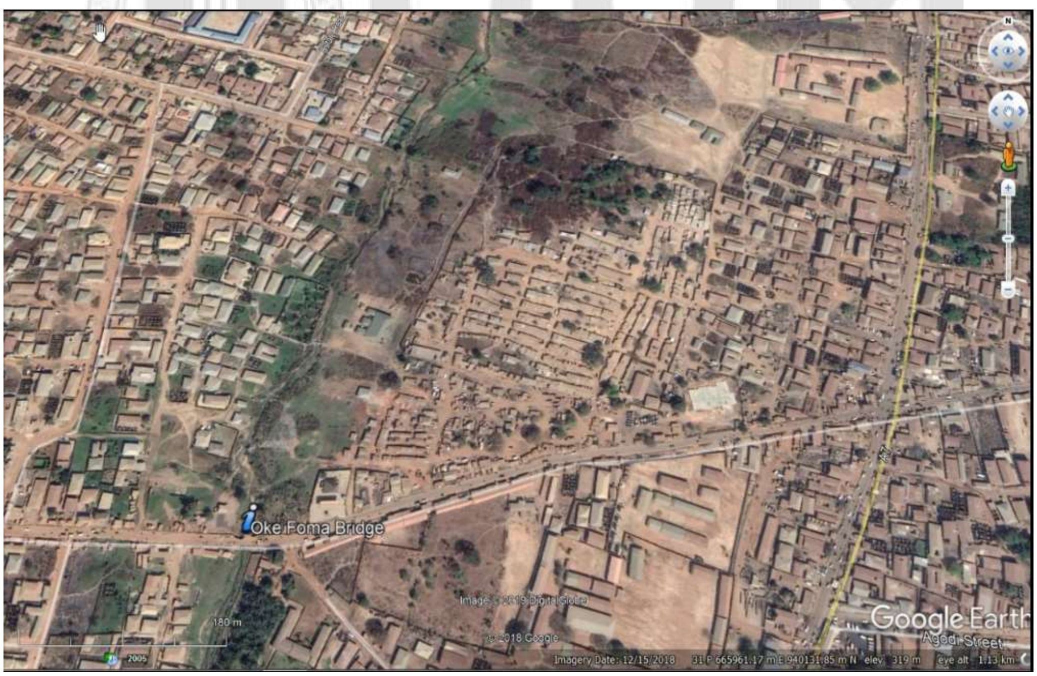

Figure 2.2: Google Imagery of the River along Okefoma Bridge

Lengths of Rivers and Tributaries along each Watershed

A) WATERSHED 1: Only has the length of river, but without tributaries

i) Main River = 1209.694m

ii) Area of the Basin for Watershed 1 = 24651303.6003m

B) WATERSHED 2: Have tributaries

i) Main River = 4796.1502m

ii) Tributaries: It have nine (9) tributaries

1) 388.699m
2) 30.7007m
3) 406.356m
4) 1266.18m
5) 61.4013m
6) 1582.12m
7) 1702.85m
8) 1359.6m
9) 1232.62m

iii) Area of Basin for Watershed 2 = 7289321.416m

WATERSHED 3: Only has the length of river, but without tributaries

i) Main River =888.0708m

ii) Area of Basin for Watershed 3 = 6189947.593m

WATERSHED 4: Have tributaries

i) Main River =3015.8174m

ii) Tributaries: It have four (4) tributaries

1) 301.734m
2) 1501.57m
3) 448.767m
4) 2980.71m

iii) Area of Basin of Watershed 4 = 10433473.522

Drainage densities were obtained for each Watershed from the data above

Appendix C
Confusion Metrix for each of the Ten (10) Folds

Table 4.1: *Confusion Matrix for Fold 1*

Actual Y	***Predicted*** $\hat{Y}$				
	0	*1*	*2*	*3*	***TOTAL***
0	*33*	*0*	*0*	*0*	*33*
1	*0*	*1*	*11*	*0*	*12*
2	*0*	*0*	*77*	*54*	*131*
3	*0*	*0*	*26*	*275*	*301*
TOTAL	***33***	***1***	***114***	***329***	***477***

Table 4.2: *Confusion Matrix for Fold 2*

Actual Y	***Predicted*** $\hat{Y}$				
	0	*1*	*2*	*3*	***TOTAL***
0	*35*	*0*	*0*	*0*	*35*
1	*0*	*1*	*12*	*0*	*13*
2	*0*	*0*	*73*	*59*	*132*
3	*0*	*0*	*22*	*275*	*297*
TOTAL	***35***	***1***	***107***	***334***	***477***

Table 4.3: *Confusion Matrix for Fold 3*

Actual Y	***Predicted $\hat{Y}$***				
	0	*1*	*2*	*3*	***TOTAL***
0	*37*	*0*	*0*	*0*	*37*
1	*0*	*1*	*11*	*0*	*12*
2	*0*	*0*	*73*	*59*	*132*
3	*0*	*0*	*23*	*273*	*296*
TOTAL	***37***	***1***	***107***	***332***	***477***

Table 4.4: *Confusion Matrix for Fold 4*

Actual Y	***Predicted $\hat{Y}$***				
	0	*1*	*2*	*3*	***TOTAL***
0	*35*	*0*	*0*	*0*	*35*
1	*0*	*0*	*12*	*0*	*12*
2	*0*	*0*	*74*	*58*	*132*
3	*0*	*0*	*23*	*275*	*298*
TOTAL	***35***	***0***	***109***	***333***	***477***

Table 4.5: *Confusion Matrix for Fold 5*

Actual Y	***Predicted $\hat{Y}$***				
	0	*1*	*2*	*3*	***TOTAL***
0	*36*	*0*	*0*	*0*	*36*
1	*0*	*1*	*11*	*0*	*12*
2	*0*	*0*	*72*	*59*	*131*
3	*0*	*0*	*24*	*274*	*298*
TOTAL	***36***	***1***	***107***	***333***	***477***

Table 4.6: *Confusion Matrix for Fold 6*

Actual Y	***Predicted $\hat{Y}$***				
	0	*1*	*2*	*3*	***TOTAL***
0	*35*	*0*	*0*	*0*	*35*
1	*0*	*0*	*12*	*0*	*12*
2	*0*	*0*	*77*	*57*	*134*
3	*0*	*0*	*21*	*275*	*296*
TOTAL	***35***	***0***	***110***	***332***	***477***

Table 4.7: *Confusion Matrix for Fold 7*

Actual Y	***Predicted $\hat{Y}$***				
	0	*1*	*2*	*3*	***TOTAL***
0	*35*	*0*	*0*	*0*	*35*
1	*0*	*2*	*10*	*0*	*12*
2	*0*	*0*	*78*	*55*	*133*
3	*0*	*0*	*24*	*273*	*297*
TOTAL	***35***	***2***	***112***	***328***	***477***

Table 4.8: *Confusion Matrix for Fold 8*

Actual Y	***Predicted $\hat{Y}$***				
	0	*1*	*2*	*3*	***TOTAL***
0	*35*	*0*	*0*	*0*	*35*
1	*0*	*0*	*13*	*0*	*13*
2	*0*	*0*	*76*	*56*	*132*
3	*0*	*0*	*26*	*271*	*297*
TOTAL	***35***	***0***	***115***	***327***	***477***

Table 4.9: *Confusion Matrix for Fold 9*

Actual Y	***Predicted $\hat{Y}$***				
	0	*1*	*2*	*3*	***TOTAL***
0	*35*	*0*	*0*	*0*	*35*
1	*0*	*1*	*11*	*0*	*12*
2	*0*	*0*	*75*	*56*	*131*
3	*0*	*0*	*21*	*278*	*299*
TOTAL	***35***	***1***	***107***	***334***	***477***

Table 4.10: *Confusion Matrix for Fold 10*

Actual Y	***Predicted $\hat{Y}$***				
	0	*1*	*2*	*3*	***TOTAL***
0	*37*	*0*	*0*	*0*	*37*
1	*0*	*1*	*11*	*0*	*12*
2	*0*	*0*	*74*	*59*	*133*
3	*0*	*0*	*24*	*271*	*295*
TOTAL	***37***	***1***	***109***	***330***	***477***