

**URBAN DRAINAGE NETWORK GENERATION USING
GEOGRAPHICAL INFORMATION SYSTEMS
-A CASE STUDY OF THREE CATCHMENTS IN
GREATER COLOMBO AREA**

**M.Eng in Environmental Water Resources Management and
Engineering**



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ABSTRACT

Establishing proper drainage system has become a major challenge especially in the urban areas. Drainage systems consist of canal network and drainage structures such as culverts. Once the drainage system is established, it can be expanded to identify the discharge at the outlet of a watershed or in flood plains for a given precipitation. Therefore identification of drainage network is a primary requirement for drainage design. Drainage network identification through engineering survey is a time consuming and costly effort. Some of the engineering applications related to drainage network such as culvert design, flood plain analysis, do not need very high accuracy. The drainage network identification can be done using less time-consuming computer technology, if the generated accuracy is satisfactory for engineering applications. Therefore this research is concentrated on the aspects related streamline generation and accuracy assessment. The main objectives of this study are,

- Generation of streamline network
- Accuracy comparison of generated streamline
- Identifying the parameters affecting the accuracy
- Accuracy comparison of observed culvert location

The study is carried out in three watersheds in the Greater Colombo region. The Torrington watershed is selected as the primary watershed for the study and the watershed area is around 450 ha. The Attidiya and Katubedda watersheds areas are found as 190 ha and 250 ha respectively.

The study requires data in digital format. Digital data extraction is carried out in three processes. Part of digital data such as existing stream network is extracted from paper maps, through scanning and geo referencing. Also digital base map features of building, roads, contours and spot heights are extracted from the database of

National Water Supply & Drainage Board (NWSDB). Rest of the digital data such as culvert locations are extracted using Global Positioning System (GPS) technology.

Data processing and analysis component is carried out using the extracted digital source data. Streamlines are generated from DEM (Digital Elevation Model) by varying the resolution from 2m, 5m, 10m, 20m and 50m. While generating streamlines on GIS, it is necessary to provide a threshold value. This threshold value is selected in a way that the level of branching off of generated and extracted streamlines at the outlet of watershed are similar. Accuracy assessment is carried out with the newly established raster based accuracy assessment method. Other than that a reference box analysis is carried out to obtain a general impression of the possible streamline pattern comes under a particular Root Mean Square Error (RMSE) value range. Accuracy variation with the change of DEM resolution at particular location and the accuracy variation along the streamline with the watershed parameters such as stream order, stream slope, surface slope, building density and stream sinuosity are observed. It is found that stream order and surface slope has a relationship with streamline accuracy. In the same way culvert location accuracies are identified by varying the resolution.

Result and discussion sections focus on the key results of data processing and analysis. It is discussed that raster based accuracy assessment is more representative when compared with vector based methods. Once the accuracies are assessed, the average accuracy variation (RMSE) with respect to different watersheds is discussed. Also accuracy variation with the resolution and the accuracy variation along the streamline with the affecting factors of stream order and surface slope are discussed. The possible reasons for unexceptional variation of streamline from the expected patterns are analyzed.

It is also discussed about establishing a representative per cell threshold value for urban watersheds. Once that is established it is possible to identify the threshold

value should be given for newly selected watersheds. Finally accuracy variations of culvert locations with respect to the resolution are also discussed in depth.

It was found that raster based accuracy assessment methodology is more realistic. Average Root Mean Square Error value (RMSE) of streamline is increased with the surface flatness of the watershed. Also in general RMSE value of generated streamline is reduced when cell size become finer. The per cell threshold value is determined as 0.016. It can be utilized to generate streamline network having same stream order of actual streamline at the outlet. It is shown that accuracy of generated streamline improves with the increment of stream order and surface slope. The deviation of observed culvert locations from the actual culvert positions varies with the resolution of DEM. Also streamline generation while incorporating building did not significantly improve the accuracy showing that there is a need for better topographic information.



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Statement
 Acknowledgement
 Abstract
 Table of Contents
 List of Tables
 List of Figures
 List of Charts
 List of Plans
 List of Abbreviation

TABLE OF CONTENTS

1.	INTRODUCTION	1-1
1.1	General.....	1-1
1.2	Background.....	1-1
1.3	Objective of the Study.....	1-3
1.4	Scope of work and Layout of the Report.....	1-3
2.	LITERATURE REVIEW.....	2-1
2.1	Ground Surface Modelling.....	2-2
2.1.1	Triangular Irregular Network (TIN).....	2-2
2.1.2	Digital Elevation Model.....	2-3
2.1.3	Accuracy Assessment of Different DEM Generation Methodology.....	2-4
2.2	Streamline Generation Methodology.....	2-6
2.3	Accuracy Assessment of Stream Network.....	2-6
2.4	Digital Map Geo Referencing and Rectification.....	2-7
2.4.1	Data Extraction Through Scanning.....	2-7
2.4.2	Digital Map/Photo Geo Referencing and Rectification.....	2-8
2.5	Data Extraction from GPS (Global Positioning System).....	2-10
2.6	Digital Base Map Feature Accuracy.....	2-12
3	METHODOLOGY.....	3-1
3.1	Flow Chart.....	3-1

3.2	Description of the Activities in the Flow Chart.....	3-2
4	DATA COLLECTION.....	4-1
4.1	Data Extraction from Paper Maps.....	4-1
4.2	Data Extraction from the NWSDB Database.....	4-3
4.3	GPS Data extraction.....	4-5
4.4	Summary of Data Collection.....	4-7
5	DATA PROCESSING AND ANALYSIS.....	5-1
5.1	Generating Streamline Network.....	5-1
5.1.1	Threshold Value of Flow Accumulation for a Given Watershed	5-3
5.1.2	Minimum Resolution for DEM.....	5-11
5.1.3	Generated Watershed Boundaries.....	5-12
5.2	Streamline Accuracy Assessment.....	5-14
5.2.1	Vector Based Accuracy Assessment.....	5-15
5.2.2	Raster Based Accuracy Assessment.....	5-22
5.2.3	Generating a Reference Box.....	5-35
5.3	Accuracy Assessment of Streamline Network for Torrington Watershed.....	5-38
5.4	Catchments Characteristics and Stream Network Generation for Torrington Watershed.....	5-38
5.4.1	Stream Order.....	5-39
5.4.2	Stream Slope.....	5-40
5.4.3	Stream Sinuosity.....	5-41
5.4.4	Surface Slope.....	5-43
5.4.5	Building Density.....	5-44
5.5	Accuracy Assessment of Streamline Network for Katubedda and Attidiya Watershed.....	5-46
5.5.1	Katubedda Watershed.....	5-46

5.5.2	Attidiya Watershed.....	5-47
5.6	Accuracy Assessment of Generated Streamlines of Building Interacted DEM (Three Watersheds).....	5-49
5.7	Relationship Between Average Accuracy and Surface Flatness of Watersheds.....	5-50
5.7.1	Torrington Watershed.....	5-50
5.7.2	Attidiya Watershed.....	5-51
5.7.3	Katubedda Watershed.....	5-51
5.8	Culvert Location Assessment.....	5-51
5.8.1	Introduction.....	5-51
5.8.2	Implementation of Culvert Location Analysis.....	5-52

6 RESULTS AND DISCUSSION

6.1	Streamline Accuracy Assessment.....	6-1.
6.1.1	Vector Based Accuracy Assessment	6-1
6.1.2	Raster Based Accuracy Assessment (Torrington Watershed)..	6-5
6.1.3	Raster Based Accuracy Assessment (Katubedda Watershed)..	6-8
6.1.4	Raster based Accuracy Assessment (Attidiya Watershed).....	6-9
6.1.5	General Discussion on Accuracy Assessment.....	6-10
6.2	Methodology to Determine a Threshold Value for a Given Watershed.	6-13
6.3	Reference Box Analysis.....	6-15
6.4	Relationship Between Catchments Characteristics and Streamline Accuracy for Torrington Watershed.....	6-15
6.4.1	Accuracy Variation With Stream Order.....	6-15
6.4.2	Accuracy Variation With Stream Slope.....	6-17
6.4.3	Accuracy Variation With Stream Sinuosity.....	6-18
6.4.4	Accuracy Variation With Stream Surface Slope.....	6-18
6.4.5	Accuracy Variation With Stream Building Density.....	6-19
6.5	Relationship Between Catchments Characteristics and Streamline Accuracy for Katubedda and Attidiya Watersheds.....	6-20

6.5.1	Katubedda Watershed.....	6-20
6.5.2	Attidiya Watershed.....	6-21
6.5.3	General Discussion.....	6-22
6.6	Accuracy Assessment of Generated Streamlines of Building Interacted DEM.....	6-23
6.7	Relationship Between Average Accuracy and Surface Flatness of Watersheds.....	6-25
6.8	Analyzing Exceptional Variation of Streamline.....	6-26
6.9	Culvert Location Assessment.....	6-30
6.10	Summary	6-31
7	CONCLUSIONS.....	7-1
8	RECOMMENDATIONS.....	8-1
9	LIST OF REFERENCES.....	9-1
10	APPENDIXES	
	APPENDIX 1 – Streamline Generation Methodology.....	A1-1
	APPENDIX 2 – Introduction to GIS Extensions.....	A2-1
	APPENDIX 3 – Streamline Generation in Flat Terrain	A3-1
	APPENDIX 4 – Tables	A4-1
	APPENDIX 5 – Figures	A5-1
	APPENDIX 6 – Plans.....	A6-1



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List of Tables

1. Tables Organized within the Text

(Tables are Numbered According to Chapters)

Table 2.a	Feature Accuracies for Different Feature Styles in Digital Base Map
Table 4.a	Details of Captured Culvert Locations in Torrington Watershed
Table 5.a	Stream Order Variation with Threshold Value of Flow Accumulation for Torrington Watershed
Table 5.b	Stream Order Variation with Threshold Value of Flow Accumulation for Attidiya Watershed
Table 5.c	Stream Order Variation with Threshold Value of Flow Accumulation for Katubedda Watershed
Table 5.d	Deviation of Generated Streamline of Segment 1 By First Method
Table 5.e	Deviation of Generated Streamline of Segment 1 By Second Method
Table 5.f	Deviation of Generated Streamline of Box 1 By Third Method
Table 5.g	Resultant Deviation Based on Second Method
Table 5.h	Average Value Determination for Each Buffer
Table 5.i	Sample Table of Generated Linear Grid
Table 5.j	RMSE Value Determination Table Based on Sample Value of Generated Linear Grid
Table 5.k	Assign Values for Buffer Zones
Table 5.l	Average Value for Buffer Zones
Table 5.m	RMSE Value Variation with the Stream Order for Torrington Watershed
Table 5.n	RMSE Value Variation with the Stream Slope for Torrington Watershed
Table 5.p	RMSE Value Variation with Stream Sinuosity for Torrington Watershed

Table 5.q	RMSE Value Variation with Surface Slope for Torrington Watershed
Table 5.r	RMSE Value Variation with Building Density
Table 5.s	Determination of Approximate Average Deviation for Katubedda Watershed
Table 5.t	Determination of Approximate Average Deviation for the Attidiya Watershed
Table 6.a	Assessment Details for the First Method
Table 6.b	Results of Vector Based Accuracy Assessment First Method for Torrington Watershed
Table 6.c	Assessment Details for the Second Method
Table 6.d	Results of Vector Based Accuracy Assessment Second Method for Torrington Watershed
Table 6.e	Results of Vector Based Accuracy Assessment Third Method for Torrington Watershed
Table 6.f	Results of Raster Based Accuracy Assessment for Torrington Watershed
Table 6.g	Results of Raster Based Accuracy Assessment for Katubedda Watershed
Table 6.h	Results of Raster Based Accuracy Assessment for Attidiya Watershed
Table 6.i	Average RMSE variation with Surface Flatness
Table 6.j	Average RMSE Percentage Increase with Resolution
Table 6.k	Average RMSE Values for Colombo Region
Table 6.l	RMSE Value Variation with Stream Order and Surface Slope for Katubedda Watershed
Table 6.m	RMSE Value Variation with Surface Slope and Stream Order for Attidiya Watershed
Table 6.n	Resultant RMSE Value Comparison for Streamlines of Building Interacted Grid for Torrington Watershed

- Table 6.p Resultant RMSE Value Comparison for Streamlines of Building Interacted Grid for Katubedda Watershed
- Table 6.q Resultant RMSE Value Comparison for Streamlines of Building Interacted Grid for Attidiya Watershed
- Table 6.r Resultant RMSE Value Variation with the Resolutions for Culvert Location in Torrington Watershed
- Table 6.s Reason for the Significant Mismatch of Streamlines

2. Tables at the APPENDIX 4

(Tables are Numbered According to Chapters)

- Table 5.1 RMSE Value Calculation of Vector Based Assessment (First Method) for Torrington Watershed
- Table 5.2 RMSE Value Calculation of Vector Based Assessment (Second Method) for Torrington Watershed
- Table 5.3 RMSE Value Calculation of Vector Based Assessment (Third Method) for Torrington Watershed
- Table 5.4 RMSE Value Calculation of Raster Based Assessment for Torrington Watershed
- Table 5.5 RMSE Value Calculation for Reference Box Analysis
- Table 5.6 RMSE Value Calculation of Raster Based Assessment for Katubedda Watershed
- Table 5.7 RMSE Value Calculation of Raster Based Assessment for Attidiya Watershed
- Table 5.8 Raster Based RMSE Value Calculation of Streamlines of Building Interacted Grid for Torrington Watershed
- Table 5.9 Raster Based RMSE Value Calculation of Streamlines of Building Interacted Grid for Katubeda Watershed
- Table 5.10 Raster Based RMSE Value Calculation of Streamlines of Building Interacted Grid for Attidiya Watershed

Table 5.11 RMSE Value Calculation for Deviation of Culvert Locations

Table 6.1 Graphical Representation of RMSE Value Variation for Streamlines
of Building Interacted Grid



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List of Figures

1. Figures Organized within the Text

(Figures are Numbered According to Chapters)

- Figure 2.a Flow of Surface Drainage Identification
- Figure 2.b GPS Data Capturing Methodology
- Figure 2.c GPS Data Capturing with Base Station
- Figure 3.a Flow Chart
- Figure 4.a New Technique Adopted for Geo-referencing the Distorted Scanned Map
- Figure 4.b GPS Data Processing
- Figure 5.a Streamline Generating Methodology
- Figure 5.b Techniques of Stream Order Analysis
- Figure 5.c Threshold Value Determination for Different Resolutions
- Figure 5.d Measuring the Deviation with First Method
- Figure 5.e Measuring the Deviation with Second Method
- Figure 5.f Measuring of Deviation of Third Method By the Rectangles
- Figure 5.g Determination of Deviation Direction Within the Rectangle
- Figure 5.h Selection of Improper Rectangle
- Figure 5.i Generating Buffer Zones inside the Box
- Figure 5.j Accuracy Variation of Streamlines for Two Different Box Sizes
- Figure 5.k Determination of Box Size
- Figure 5.l Accuracy Variation of Streamlines for Boxes by Varying the Number of Buffer Zones

- Figure 5.m Accuracy Variation of Streamlines for Boxes by Varying the Buffer Zone Sizes
- Figure 5.n Critical Situation for Comparison - 1
- Figure 5.p Critical Situation for Comparison - 2
- Figure 5.q Critical Situation for Comparison - 3
- Figure 5.r Critical Situation for Comparison - 4
- Figure 5.s Average Value Determination for Each Buffer Zone
- Figure 5.t Stream Sinuosity Analysis
- Figure 6.a RMSE Value Variation with Resolution in Flat Terrain
- Figure 6.b Threshold Value Analysis Based on Per Cell Threshold Value of Flow Accumulations (Varying Threshold)
- Figure 6.c Threshold Value Analysis Based on fixed Threshold Value of Flow Accumulation
- Figure 6.d Streamline Deviation Due to building Interaction
- Figure 6.e Artificially Constructed Streams



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2. Figures at the APPENDIX 5

(Figures are Numbered According to Chapters)

- Figure 4.1 Geo referenced Scan Map in the Torrington Watershed
- Figure 4.2 Geo referenced Scan Map in the Attidiya Watershed
- Figure 4.3 Extracted Watershed Boundary for Torrington Watershed
- Figure 4.4 Extracted Watershed Boundary for Attidiya Watershed
- Figure 4.5 Aerial Photograph Mosaic for Katubedda Watershed
- Figure 5.1 Spot Heights and Contours in the Torrington Watershed
- Figure 5.2 TIN Model for the Torrington Watershed
- Figure 5.3 DEM in the Torrington Watershed
- Figure 5.4 Filled DEM in the Torrington Watershed
- Figure 5.5 Flow Directions in the Torrington Watershed
- Figure 5.6 Flow Accumulations in the Torrington Watershed

- Figure 5.7 Comparison of Extracted and Generated Streamline in the Torrington Watershed
- Figure 5.8 Outlet Location Based Generated Watershed for Torrington Watershed
- Figure 5.9 Relationship of Extracted Watershed Boundary and the Existing Road Network for Torrington Watershed
- Figure 5.10 Generated Streamline within the Extracted Watershed Boundary for Torrington Watershed
- Figure 5.11 Generated and Extracted Watershed Boundary at Attidiya Watershed
- Figure 5.12 Vector Based Accuracy Assessment (First Method) for Torrington Watershed
- Figure 5.13 Vector Based Accuracy Assessment (Second Method) for Torrington Watershed
- Figure 5.14 Vector Based Accuracy Assessment (Third Method) for Torrington Watershed
- Figure 5.15 Raster Based Accuracy Assessment for Torrington Watershed
- Figure 5.16 Arrangement of Boxes for Raster Based Accuracy Assessment in the Torrington Watershed
- Figure 5.17 Enlarged Buffer Zone for Raster Based Accuracy Assessment (Torrington Watershed)
- Figure 5.18 Resultant Generated Streamline (Grid Form) After the Analysis
- Figure 5.19 Streamline Patterns used for Reference Box Analysis
- Figure 5.20 Stream Order Numbers Relevant to Each Box under the Stream Order Analysis for Torrington Watershed
- Figure 5.21 Stream Slope Values Relevant to Each Box under the Stream Slope Analysis for Torrington Watershed
- Figure 5.22 Stream Sinuosity Determination for Each Boxes Under the Stream Sinuosity Analysis for Torrington Watershed

- Figure 5.23 Generation of Building Density Grid for Building Density Analysis for Torrington Watershed
- Figure 5.24 Approximate Accuracy Assessment for Katubedda Watershed
- Figure 5.25 Raster Based Accuracy Assessment for Katubedda Watershed
- Figure 5.26 Approximate Accuracy Assessment for Attidiya Watershed
- Figure 5.27 Raster Based Accuracy Assessment for Attidiya Watershed
- Figure 5.28 Building Incorporated Grid Used for Streamline Generation for Torrington Watershed
- Figure 5.29 Generated Streamlines from Building Incorporated Grid for Torrington Watershed
- Figure 5.30 Building Incorporated Grid Used for Streamline Generation for Katubedda Watershed
- Figure 5.31 Generated Streamlines from Building Incorporated Grid for Katubedda Watershed
- Figure 5.32 Building Incorporated Grid Used for Streamline Generation for Attidiya Watershed
- Figure 5.33 Generated Streamlines from Building Incorporated Grid for Attidiya Watershed
- Figure 5.34 Slope Surface for Surface Flatness Analysis in the Torrington Watershed
- Figure 5.35 Slope Surface for Surface Flatness Analysis in the Attidiya Watershed
- Figure 5.36 Slope Surface for Surface Flatness Analysis in the Katubedda Watershed
- Figure 5.37 Identification of Culvert Location Accuracy for Torrington Watershed
- Figure 6.1 Line Patterns under RMSE Value Ranges

List of Charts

1. Charts Organized within the Text

(Charts are Numbered According to Chapters)

- Chart 5.a Stream Order Variation with Threshold Value of Flow Accumulation for Torrington Watershed
- Chart 5.b Stream Order Variation with Threshold Value of Flow Accumulation for Attidiya Watershed
- Chart 5.c Stream Order Variation with Threshold Value of Flow Accumulation for Katubedda Watershed
- Chart 6.a Vector Based Accuracy Assessment (Second Method) for Torrington Watershed
- Chart 6.b Vector Based Accuracy Assessment (Third Method) for Torrington Watershed
- Chart 6.c Raster Based Accuracy Assessment for Torrington Watershed
- Chart 6.d Raster Based Accuracy Assessment for Katubedda Watershed
- Chart 6.e Raster Based Accuracy Assessment for Attidiya Watershed
- Chart 6.f Streamline Accuracy Variation with Stream Order for Torrington Watershed
- Chart 6.g Streamline Accuracy Variation with Stream Slope for Torrington Watershed
- Chart 6.h Streamline Accuracy Variation with Stream Sinuosity for Torrington Watershed
- Chart 6.i Streamline Accuracy Variation with Surface Slope for Torrington Watershed
- Chart 6.j Streamline Accuracy Variation with Building Density for Torrington Watershed
- Chart 6.k Streamline Accuracy Variation with Surface Slope & Stream Order for Katubedda Watershed
- Chart 6.l Streamline Accuracy Variations with Surface Slope & Stream Order for Attidiya Watershed

Chart 6.m Average Accuracy Variation with the surface Flatness of Watersheds

Chart 6.n Culvert Location Analyses for Torrington Watershed



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List of Plans

1. Plans Organized within the Text

(Plans are Numbered According to Chapters)

Plan 4.a Location Map of Watersheds

2. Plans at the APPENDIX 6

(Plans are Numbered According to Chapters)

Plan 4.1 Torrington Watershed

Plan 4.2 Katubeda Watershed

Plan 4.3 Attidiya Watershed



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List of Abbreviations

DEM	-	Digital Elevation Model
TIN	-	Triangular Irregular Network
NWSDB	-	National Water Supply & Drainage Board
SLLRDC	-	Sri Lanka Land Reclamation & Development Cooperation
IDW	-	Inverse Distance Weighted
GPS	-	Global Positioning System
RMSE	-	Root Mean Square Error
GIS	-	Geographical Information System
UDA	-	Urban Development Authority
3D	-	Three Dimensional
GC	-	Greater Colombo



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