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 patters 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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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