1 INTRODUCTION

1.1 General
Streamflow is a central component of human water requirement for agriculture, drinking and domestic water, sanitation, recreation and for natural environmental sustenance. It is also a reliable habitat for major aquatic plants and animals while replenishing aquifers. As a result of population growth and economic development activities, the demand on these limited resources is increasing exponentially. As the supply of fresh water is limited and the demand is ever increasing, future of the world is at stake unless suitable measures are taken for rational water resources management. Water related disasters such as floods, landslides, and mud-slips also pose a significant threat to global food security, natural habitat and dwelling. Therefore, efficient management of water resources, flood mitigation and adaptation strategies are critical for sustainable development. Water plays a vital role in social and economic development of a nation.

Sri Lanka is an island near the southern tip of India receiving rainfall from two monsoons namely, the South-West (October-March) and the North-East (April-September). In terms of annual rainfall value, Sri Lanka falls into the category of countries with little or no scarcity of water, however when treating the country as a whole, this statement is misleading due to the fact that there is significant spatial and temporal variation leading to abundance in some seasons and places, while scarcity prevails in some regions during many months (Amarasinghe, Sakthivadivel and Mutuwatta, 1999). Flood is a major issue in Sri Lanka during the peak monsoon season causing damage to crops, livestock, human lives, settlements and infrastructure. The number of people affected by different disasters in Sri Lanka between the years 1974 & 2004 amounts to 2,964,655 from flood, 2,072,512 from drought and 1,009,474 from Tsunami (Ministry of Disaster Management [DDM], 2014).

Sri Lanka consists of 103 major river basins and the Irrigation department is responsible for maintaining 31 river gauging stations (Hydrological Annual, 2010/2011). Many rivers in Sri Lanka are not gauged and available gauged data are
commonly in daily time resolution. As a country looking forward to achieve rapid development, accurate flow estimations for water resource management and drainage designs is extremely important. Representative streamflow estimations are essential for flood forecasting and associated disaster management. Therefore, in order to ensure best estimates of watershed responses for given rainfall, it is important to use models which adequately represent watersheds.

In case of Sri Lanka, research work on mathematical modelling of streamflow is limited. Reviewing approximately 100 Sri Lankan studies on water resources and modelling, Wijesekera (2010a) revealed that most of the streamflow modelling had used monthly datasets and demonstrated only limited modelling efforts. The work also reported that watershed modelling research had not demonstrated the establishment of methods and results for practical applications with confidence. Wijesekera and Ghanapala (2003) demonstrated the calibration and verification of a hydrologic model developed for two low lying watersheds in Colombo namely, Torrington and Badowita-Attidiya having sizes of 290 & 270 ha respectively. Silva (2006) derived a mathematical model to forecast the runoff ratio of Rathnapura catchment in Kelu Gangawa basin and recommended to investigate the model prior to applying in other Sri Lankan catchments. Modelling for runoff coefficient of Karasnagala basin considering soil type, land use pattern and slope of the catchment by Wijesekera and Perera (2011), determined an average runoff coefficient of 0.52.

Not only in Sri Lanka but elsewhere in the world, estimating streamflow in an ungauged watershed is an important challenge because most of engineering infrastructure development activities take place in such areas. There are many methods to estimate the streamflow hydrograph resulting from a storm over a catchment. Out of these, a popular method is the unit hydrograph (UH) method (James & Wurbs, 2002). Visseman, Lewis and Knapp (1989) explains UH concept as introduced by Sherman in 1936 to compute the Direct Runoff Hydrograph (DRH) from a particular effective rainfall on to a watershed. Chow, Maidment and Mays (2013) states Synthetic Unit Hydrograph (SUH) procedures are used to develop unit hydrographs for other locations on the stream in the same watershed or for the
nearby watershed having similar physical characteristics of a corresponding watershed. Over several decades Synthetic Unit Hydrograph method had been applied throughout the world to generate direct runoff hydrographs in case of many engineering applications (Mays, 2004). There are several methods to develop a SUH for a watershed and they are, SCS Dimensionless Unit Hydrograph, Snyder and Clark methods, Snyder’s method and the method using Rational formula (Chow et al. 1988; Wijesinghe & Wijesekera, 2011). The SUH generation using either of these methods had been practiced in many other countries. Salami (2009) carried out a study on lower Niger River Basin with a catchment area of 7500 km², the peak flow value obtained from Snyder’s method was much closer in comparison to the Gray’s method and had a difference of 48% Wijesekera (1998) modelled the Colombo harbour watershed to estimate the discharges from the outlets using four different models. In this work the Snyder’s method had showed the highest peak flow rate of 8m³/sec with average Ct and Cp values of 4.71 & 0.64 respectively.

In a comparative application on Sri Lankan watersheds, Batuwitage, Manchanayake, and Wickramasuriya (1986) concluded that peak flows of the design flood of Snyder’s method gives higher values than those obtained by a statistical method. Wijesinghe and Wijesekera, (2012) applied SCS method for the Attangalu Oya watershed, where the simulated and observed hydrographs for 60 events produced a good match with MRAE of 0.34.

Identification of a reliable SUH is a very important task for Sri Lanka's development activities in ungauged watersheds and this requires reliable watershed parameters. Though the Irrigation Department guidelines (Ponrajah, 1984) provides SUH parameters for twenty two Sri Lankan watersheds, studies in research literature suggest that there is need to strengthen the reliability of these parameters. Evaluating the variability of SUH parameters for a watershed can be done by modelling the observed streamflow considering individual rainfall and streamflow events.

Event based models enable the evaluation of event to event parameter variation thereby providing the opportunity to judge the adequacy of available values while providing opportunity to validate using averaged parameters for the derivation of
SUH. This also enables capturing the magnitude of error that could be expected when a SUH is developed for a watershed using a particular set of parameters. The present work on event based modelling of Karasnagala watershed in Attanagalu Oya using the Snyder’s Synthetic Unit Hydrograph method was carried out considering the importance of identifying the reliability of SUH parameters and evaluating the suitability of averaged parameters and while recognizing the limited work done in Sri Lanka.

1.2 Objective of the Study

1.2.1 Overall Objective

The main objective of the study was to carry out an event based rainfall and streamflow modelling study using Snyder's Synthetic Unit Hydrograph method in order to evaluate its parameters on runoff hydrograph generation.

1.2.2 Specific Objectives

The present study is to carry out rainfall event based modelling of Attanagalu Oya watershed at the Karasnagala gauging point had the following specific objectives.

The specific objectives of the study are:

i. To identify the best methodology and carry out baseflow separation from the observed streamflow hydrographs in order to develop the observed direct runoff hydrographs.

ii. To develop, calibrate and verify the Snyder's Synthetic Unit Hydrograph model for the Karasnagala watershed.

iii. To evaluate the effect of Snyder's Synthetic Unit Hydrograph parameters on the generation of streamflow in Karasnagala watershed and to make suitable recommendations when developing Synthetic Unit hydrographs for ungauged watersheds.