Statistical Model for Flows of Kalu Ganga

At Ellagawa

By

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The work described in this thesis was carried out by me under the supervision of P. Dias and a report on this has not been submitted in whole or in part to any university or any other institution for another Degree/Diploma.

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K.D.V.F. Siriwardana

I certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the university for the purpose of evaluation.

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P. Dias

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Definitions

Runoff response

The amount of water, which flow passing per given place in a river, due to the rainfall occurring, in the catchment area of that particular point.[9]

Runoff

That part of the precipitation, snow melt, or irrigation water that appears in uncontrolled surface streams, rivers, drains or sewers is called as runoff. Runoff may be classified according to speed of appearance after rainfall or melting snow as direct runoff or base runoff, and according to source as surface runoff, storm interflow, or ground-water runoff[9]. The sum of total discharges described in above, during a specified period of time is defined as runoff [9] .

Stream Flow

The record of a flow at a gauging station represents the intergrated runoff for the entire basin above the station[8]. In many areas the production of runoff is not uniform over the basin.

Stream flow data are usually publish in the form of average daily flows. This is the average discharge rate in cubic meters per second.

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ABSTRACT

Kalu Ganga is the second largest river in Sri Lanka in terms of annual volume of runoff to the sea. Being situated entirely in the wet zone of Sri Lanka, it has a high rainfall to runoff response and the water is discharged as floods. The floods in Kalu Ganga are a regular feature, but it is difficult to predict the time of flood or amount of floods. Floods cause less damage to plantations in the upper reaches, but cause more damage in lower reaches below Ellagawa. In this study a statistical model was developed to predict the amount of floods below Ellagawa ($R^2 = 0.70$, $p < 0.001$) on a given day. The response variable of the model was flow value (cm^3 per second). Based on the amount of flow value, the gravity of flood can be decided. As extreme flow values are important in forecasting floods, the flow data measurements when the previous days flow is greater than 200 cubic meters per second were used as predictive variables for the model. Daily data from January 2001 to December 2006 were used in model building. To predict the flow of a given day, the flow on the previous day ($p < 0.05$) and two days before ($p < 0.05$), the average rainfall on the previous day($p < 0.1$) and two days before($p < 0.1$) and relative humidity ($p < 0.05$) on the previous day were found as significantly important variables for the model. The daily average rainfall of the catchments area was found using the Thessean Polygon Method based on the rainfall of the available eleven locations around the catchments area. Out of many predictor variables, the inclusion of the selected variables was decided using partial F-test in forward selection procedure, backward illumination procedure and best subsets. A model which is suitable for prediction is selected as the best model. The model was tested

for available data over the period of January 2007 to June 2008 and found that the model works well. The observed and predicted values were highly significantly correlated ($r=0.93$, $p< 0.001$). The randomness of the errors was tested using autocorrelation function. A formula to find the probability of reaching the flow at Ellagawa to flood level(900 cm^3/s) or to above the flood level is derived. The model is practically flexible and can be used for early warning floods for below Ellagawa.

Chapter 1

Introduction

1.1 The Kalu Ganga Basin

The Kalu Ganga is the second largest river in Sri Lanka in terms of annual volume of runoff to the sea. At Kaluthara where it enters the Indian Ocean it drains an area of 2688 km^2[1]. Kalu Ganga is the fourth longest river in Sri Lanka (see Table 1.1). Annually it discharges around a volume of water 7862 MCM (Million Cubic Meters)[1]. Being situated entirely in the wet zone of Sri Lanka, it has a high rainfall to runoff response (see Table 1.2). This high volume of water is often discharged as floods.

Name of the River	Length in km
Mahaweli Ganga	335 km
Kelani Ganga	145 km
Walawey Ganga	138 km
Kalu Ganga	**129 km**

Table 1.1 : Lengths of main rivers in Sri-Lanka

Source : The National Atlas of Sri Lanka[1]

Most of the rainfall received by Sri Lanka occurs during the two main monsoon seasons. Due to its geographical location, the catchment of Kalu Ganga receives rain during both monsoons, i.e, from the North East monsoon (December to February) and from South West

monsoon (May to September). Upstream parts of the catchment receives annual rainfalls as high as 5000-6000 mm[1] while the average annual rainfall received by the overall catchment is around 4400 mm[2].

River	Catchment Area in km^2	Precipitation Volume in MCM	Annual Discharge Volume to the sea in MCM	Discharge as a % of Presipitation
Kalu Ganga	**2688**	**10122**	**7862**	**77%**
Kelani Ganga	2278	8692	5474	62%
Mahaweli Ganga	10327	26804	11016	41%
Walawe Ganga	2442	9843	2165	22%

Table 1.2 : Precipitation to the runoff response of main rivers in Sri Lanka

Source : The National Atlas of Sri Lanka[1]

In the upper basin, river slopes are steep and valleys are narrow. In the middle and lower reaches the slopes are mild and the valleys are wide and flat. Further in the downstream the river is enclosed by levees where the river bed is above immediate flood plain.

1.2 Kalu Ganga Floods

Heavy rainfalls over the catchment, steep river slopes with narrow valleys in the upper catchment, and mild riverbed slopes with wide and flat plains in the middle and lower

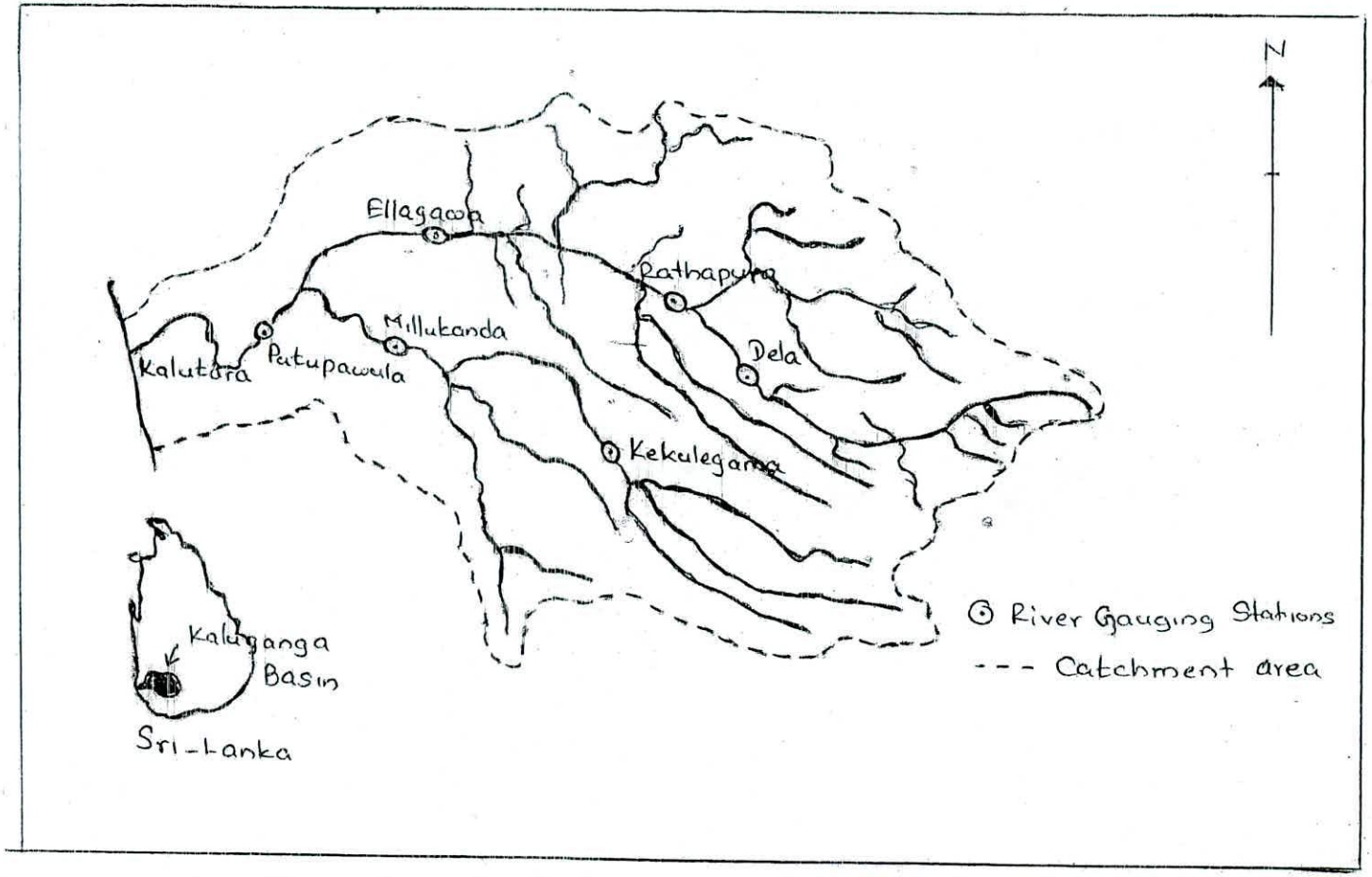

Fig 1.1 : The Kalu Ganga Catchment

Source : Sri-Lanka Map (1:250000)

catchments, make the floods in Kalu Ganga basin a regular feature[2]. The Kalu Ganga catchment is shown in the Fig 1.1

Kalu Ganga floods occur very frequently in the areas surrounding the Rathnapura and Kaluthara districts.

According to The study of flood levels in the Rratnapura municipal council area by Asian Urban Disaster Mitigation Programme, 1999[2]

> "The town is located at the confluence of two large tributaries of Kalu Ganga of nearly equal drainage area. A change in riverbed slopes occurs around this area as the river emerges from the relatively steep slopes of the upper catchment in to relatively mild slopes of the middle catchment. Some parts of the Rathanpura town and the outlying villages are located in low lands, which are very close to the riverbed level. In addition, town of Rathnapura is located just below the part of Kalu Ganga catchment, which receives the highest annual rainfall.
>
> Floods of nearly annual occurrence in Rathnapura town and its vicinity are of great concern as they disrupt the day today life of the community for several days or weeks. The economic loss due to these flood events is also very significant. "

Kalutara District is also severely affected by Kalu Ganga floods regularly. On 25th April, 1999 Sunday Times[3] reported that due to Kalu Ganga floods 151 families in Horana ,