FLOOD HAZARD MAPPING FOR KALANI RIVER BASIN – SRI LANKA

ICHARM GRIPS Student Member ○ Nalin Ranasinghe
ICHARM Regular Member Takahiro Sayama
ICHARM Regular Member Shigenobu Tanaka
ICHARM Regular Member Ai Sugiura
ICHARM Duminda Perera

1. INTRODUCTION

Sri Lanka is suffering from frequent flooding and it has affected more than 16 million people in the country for the last 32 years. Resent statistics shows that the number of flood occurrence from 1980 is 60 and the annual economic loss is around US$ 55 million. The geography and topography of Sri Lanka bring large annual rainfall to the country. The mean annual rainfall of the country ranges between 900 mm and 5,500 mm, with an island-wide average of about 1,900mm (Figure 1). The total amount of fresh water received annually is 131,230 million m^3. The average annual river flow, which is 31% of the rainfall, is 40,680 million m^3. The Monsoon rain received in central highlands is carried down as surface run off, through the 103 distinct natural river basins covering 90% of the island, and 25 river basins are vulnerable to frequent floods. This shows the necessity of structural and nonstructural countermeasures.

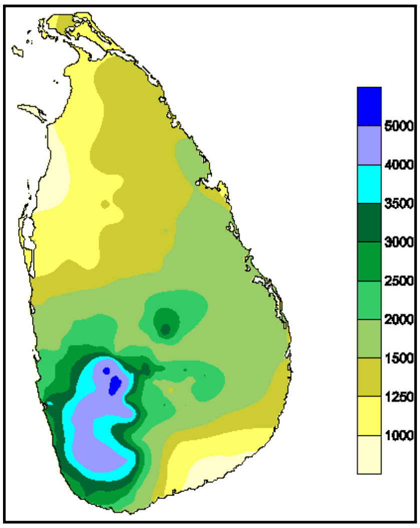

Figure 1. Annual Rainfall Distribution.

The fourth largest river in Sri Lanka is the Kalani River. This river is very important since it flows through Colombo, the most urbanized area in Sri Lanka, and provides 80% of water requirement of the capital city. However the downstream of the Kalani River is vulnerable for frequent floods every year.

This paper introduces Rainfall-Runoff-Inundation Model (RRI Model) simulation carried out for the Kalani River basin. The RRI model is a two-dimensional model capable of simulating rainfall-runoff and flood inundation simultaneously (Sayama et al., 2012). The model simulates slopes and river channels separately. The flow on the slope grid cells is calculated with the 2D diffusive wave model, while the channel flow is calculated with the 1D Kinematic wave model of the Saint-Venat unsteady flow equation. For better representations of rainfall-runoff-inundation processes, the RRI model simulates lateral subsurface flow, vertical infiltration flow and surface flow. The flow directions change based on water levels in the RRI model while they are fixed with the distributed R-R model. The model assumes rectangular river cross section and the levee height can be assigned to each grid cell while the infiltration is considered as a loss. Further the water level and the river discharge can be applied as a boundary condition.

2. APPLICATION OF RRI MODEL TO THE KALANI RIVER BASIN.

Topographic data, flow accumulation, flow direction of the study area and the rain fall from the previous flood event were prepared for the model setup. The model was calibrated by using observed hydrometric data at a hydrometric gauging station located 30 km upstream of the river mouth and the inundation records. The infiltration loss was estimated by Green-Ampi model. River geometry, roughness of the river and the catchment and soiltype of the catchment were also used as the input parameters for the model.

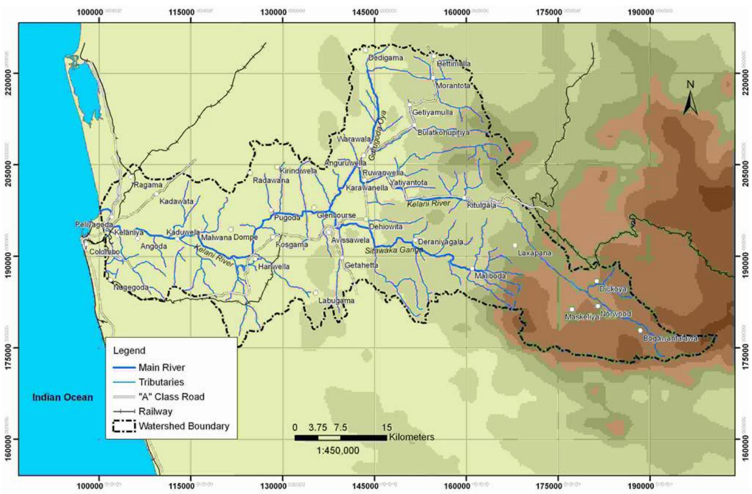

Figure 2. Study area

3. RESULTS

RRI Simulation was carried out for the flood event in May, 2008. Simulated and observed hydrographs are shown in Figure 3 while Table 1 shows the evaluation indices including Relative Root Mean Squire Error (RRMSE), NS coefficient

Keywords: Flood inundation, RRI Model, Gumbel, GEV, return period
Contact data: Nalin Ranasinghe., email : nkranasinghe@gmail.com

of efficiency (EF) and coefficient of determination (CD). Model was tested for the July flood event at the same year, and simulated and observed hydrographs are shown in the Figure 4. In these two figures (Figure 3 and 4), most of the simulation outputs are much closer to the observed points except the difference at the beginning. Due to infiltration losses, the initial discharge may not agree with the observed data.

Finally, different inundation outputs can be obtained from the calibrated model for different return periods. Figure 5 shows the inundation simulation output which was carried out for 50-year return period rainfall. Here the authors used historical daily rainfall data to obtain return period rainfalls, and the frequency analysis was carried out by using two-day maximum rainfall which was the main cause of the flood in the basin. The authors found that the Gumbel distribution was best fitted with the observed data from the Gumbel and GEV plots.

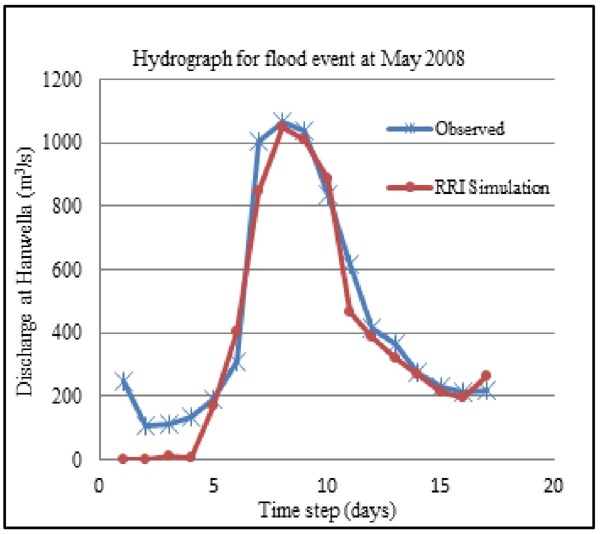

Figure 3. Simulation results for flood event May 2008

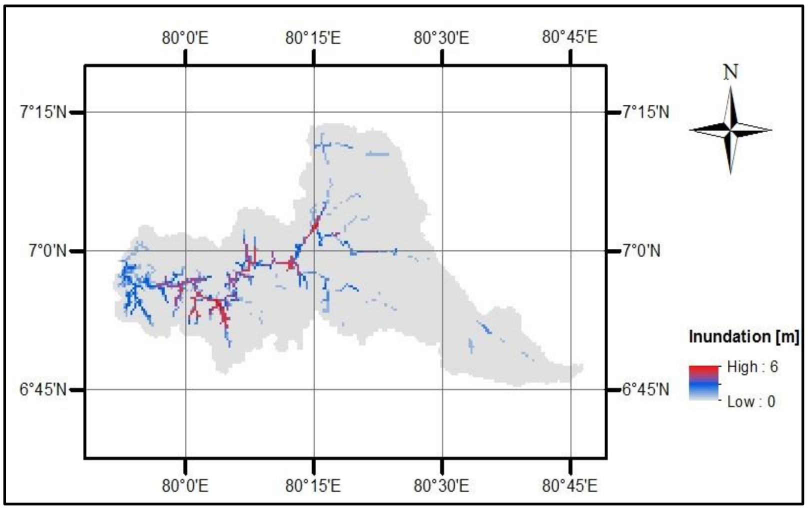

Figure 5 Inundation map for 50 year return period

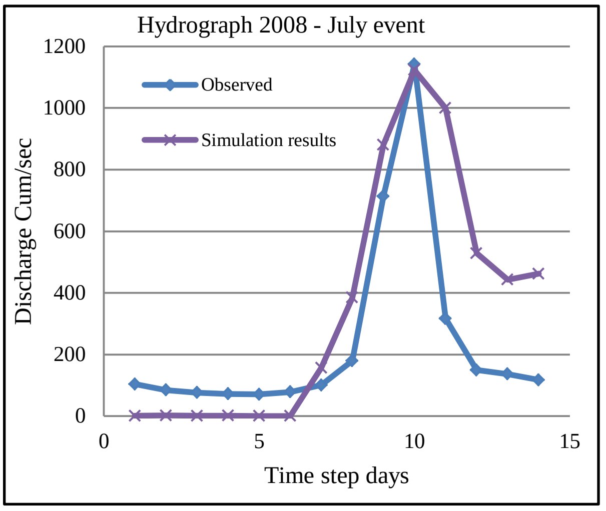

Figure 4. Simulation results for flood event July 2008

Table 1. Evaluation of Hydrograph Simulation

Statistical Indices	Simulation Results	Optimal Value	Range
Relative Root Mean Squire Error (RRMSE)	0.223	0	> = 0
N - S Coefficient of Efficiency (EF)	0.908	1	> - ∞ and = < 1.0
Coefficient of Determination (CD)	0.906	1	> 0 and = < + ∞

4. CONCLUSION.

Sri Lanka has been experiencing natural disasters mainly caused by floods, cyclones, landslides and tsunami. Due to encroachment and poor maintenance, a complete rehabilitation of this flood protection scheme has now become absolutely necessary. The RRI model is useful for inundation analysis and damage assessment. In this study, the authors developed an inundation map corresponding to the return period that will be used as the basis for damage assessment, risk management, and improvement of early warning systems and hazard mapping. Further, this approach can be applied to the other rivers in Sri Lanka which have a basin area of more than thousand square kilometers.

5. REFERANCES

Amarasekara, J.D.: Development of a Flood forecasting model for Gin River and Kelani River Basin in Sri Lanka using Fuzzy Logic Approach,2012, Master Thesis, GRIPS,**p,65*

Sayama, T., Ozawa, G., Kawakami, T., Nabesaka, S., Fukami, K.: 2011. Rainfall-Runoff-Inundation analysis of the 2010 Pakistan flood in the Kabul River basin, Hydrological Sciences Journal, 57(2), pp. 298-311