# Application of geographical information systems for flood risk mapping: a case study of Ratnapura town

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**Abstract**

*The objective of this study was to assess the risk of different flood scenarios for Ratnapura town due to flash floods and estimate the flood inundation areas according to the wardwise of the town area. The data and information of the study gathered from different ways such as digital contour data (1:50,000), wardwise base map of the municipal area (1:5000), and flood flow data (1977 – 2003), at the Ratnapura gauging station.*

*Using the Gumble method, flood frequency analysis was performed to assess the flood return period and the probability of floods. The GIS data analysis was done using ILWIS 3.2 functions. After geometric corrections of digital contour data, Digital Elevation Model (DEM) was created. Results of the flood frequency analysis, flood scenario maps were produced. Wardwise extents of flood inundation areas were also calculated.*

*Results revealed that the highest floods would occur every 200 years and the inundation area would be 1115.0 ha with a probability of 0.5%, followed by in every 100 years the inundation area would be 1086.2 hectares with a probability of 1%, in every 50 years the inundation area would be 974.2 hectares with a probability of 2% and so on and so forth. The lowest floods would occur every year and inundation area would be 65.9 hectares with 99% probability.*

**Key words**: Flood risk mapping, GIS, ILWIS

## Introduction

The formulation and implementation of appropriate flood loss prevention and management strategies is the task of flood risk analysis and mapping. The first stage of any comprehensive flood loss prevention and management exercise must be the delineation of zones subject to inundation by floods of different magnitude and different frequency. Flood risk analysis and mapping identifies the nature and extent of the flood problem by actually assigns the flood hazard by the process of flood risk mapping. The intended effort of flood risk maps is to cause the revision of all planning maps for the area. Aside from development planning, it should also affect the planning of roads, services, parks and emergency services.

Ratnapura town is located behind Kalu Ganga, which is the third longest river in Sri Lanka. However it discharges the largest volume of water to the sea. Flooding of Ratnapura town has been a frequent occurrence. The Ratnapura town is subject to floods when river level rises up to 18m.msl and the worst flood which occurred in 1913, 1940, 1941, 1989 and 2003, recharge level slightly above 24.5m. msl.

The main purpose of this study was to assess the risk of different flood scenarios for Ratnapura town, based on flood flow data (1977 – 2003) at the Ratnapura gauging station, using ILWIS 3.2 functions. To achieve the main objective, following studies have been carried out.

(i) Assess the risk of different flood scenarios for Ratnapura town.
(ii) Estimate the flood inundation areas of the Ratnapura town.

## Materials and Methods

Ratnapura Municipal Council (MC) area is located between 6 41 and 6 42 north latitudes and 80 23 east to 80 24 east longitudes. The extent of Rathnapura MC area is 2218.4 hectares. The contour height varies from 18m to 305m within the town limit. Ratnapura MC area consists of 15 wards with a total population of 45822 people.

Wardwise base map of the municipal area (1:5000) was used as the base map. Digital contour data (1:50,000) of the area, prepared by the survey department were used to create the Digital Elevation Model(DEM). Topographic maps of the Ratnapura area were used for reference.

### Data analysis

Past flood records during the period 1977-2003 at the Ratnapura gauging station were used for the flood frequency analysis. The return period and probability of floods were assessed through the Gumble method (Sharma, 1979).

Return period = N+1/r (N=Number of years, r =Rank)
Probability (P%) = 100/r (P = Probability, r = Return period)

All GIS data analysis was done using ILWIS 3.2 functions. After geometric corrections of digital contour data, Digital Elevation Model (DEM) was created. Using the results obtained from the flood frequency analysis, flood scenario maps (flood inundation maps) were generated through the DEM.

## Results and Discussion

Gumble method helps to estimate the return period and probability of year 200, 100, 50, 40, 30, 20. 10, 5 and year 1 flood return periods and probability (Table 1).

**Table 1. Return period and probability of floods**

| Max. Depth (m) | Return Period (years) | Probability % |
|---|---|---|
| 18 | 1 | 99 |
| 207 | 2 | 50 |
| 22 | 5 | 20 |
| 23 | 10 | 10 |
| 25 | 20 | 5.6 |
| 26 | 30 | 04 |
| 28 | 50 | 02 |
| 30 | 100 | 01 |
| 32 | 200 | 0.5 |

Eight flood scenario maps (Figures 1 – 8) were generated using the results obtained from the flood frequency analysis.

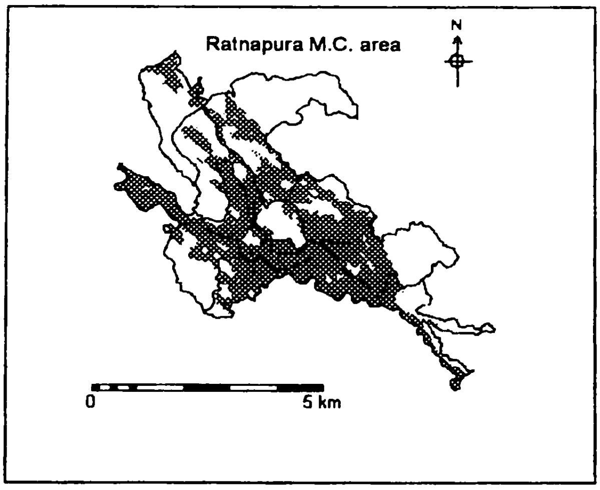


**Fig. 1: 200 year flood inundation map**

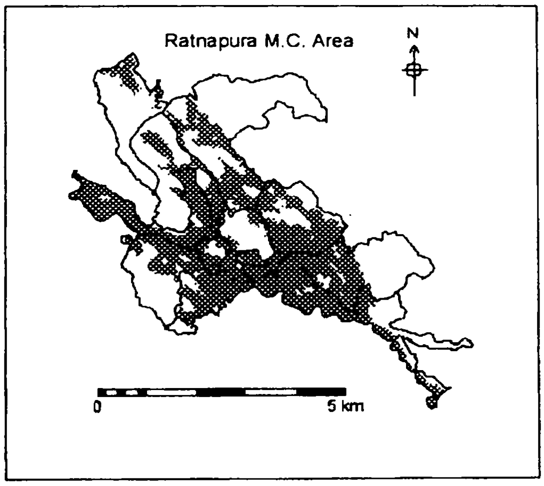


**Fig. 2: 100 year flood inundation map**

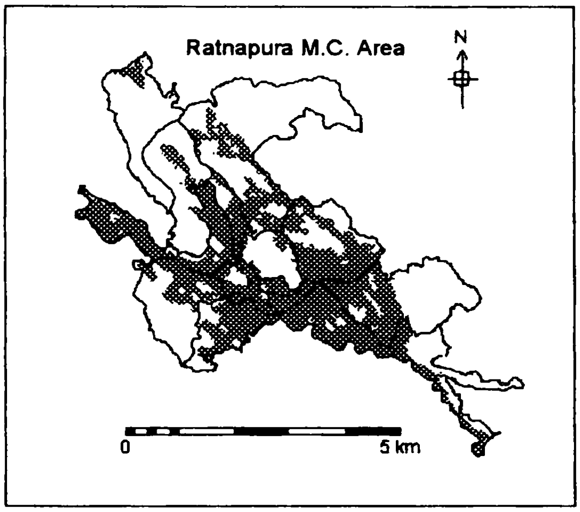


**Fig. 3: 50 year flood inundation map**

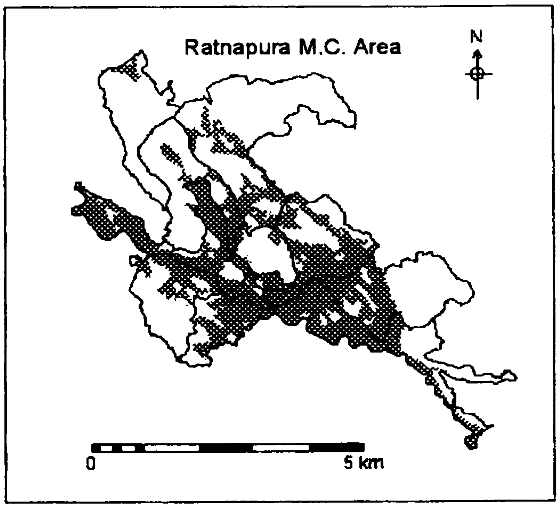


**Fig. 4: 30 year flood inundation map**

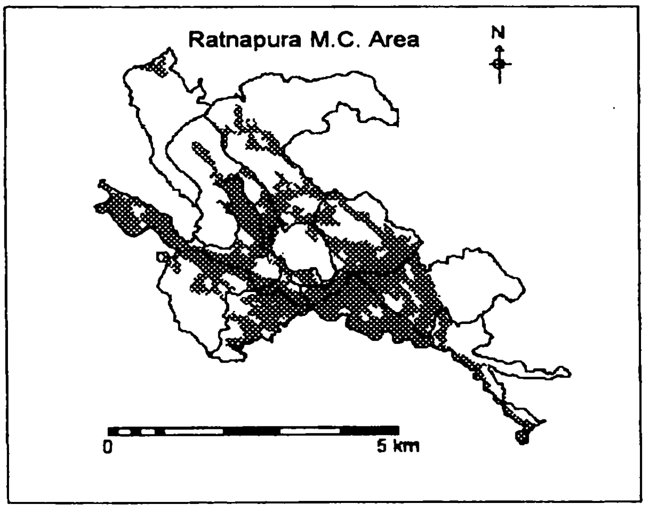


**Fig. 5: 10 year flood inundation map**

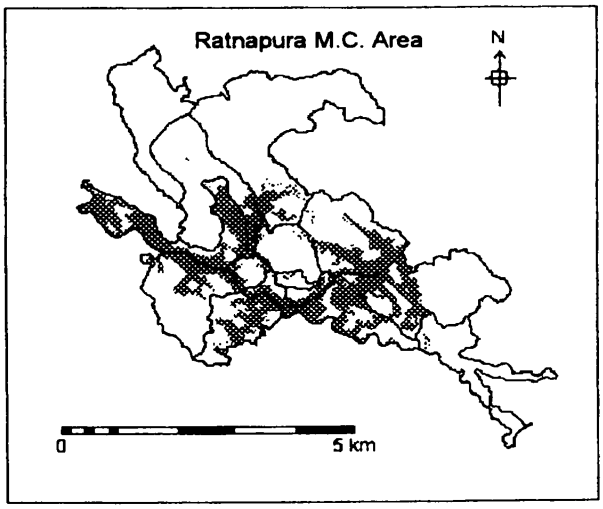


**Fig. 6: 05 year flood inundation map**

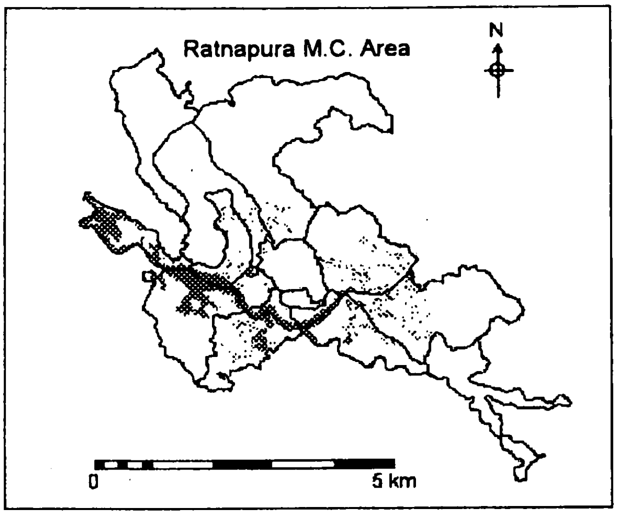


**Fig. 7: 02 year flood inundation map**

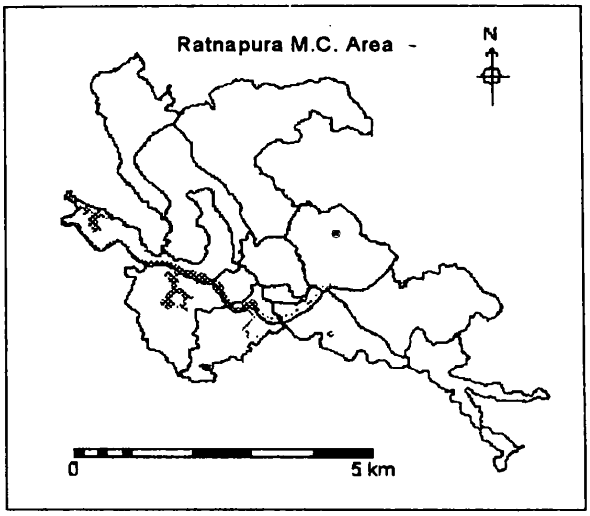


**Fig. 8: 01 year flood inundation map**

The blue color illustrates (figures 1-8) the flood inundation area. The total land extent of flood inundated areas according to the return periods are illustrated in table 2.

**Table 2. Land extent of flood inundated areas according to the return periods**

| Return Period (years) | Inundated Area (ha.) | % |
|---|---|---|
| 200 | 1115.0 | 49.6 |
| 100 | 1086.2 | 48.4 |
| 50 | 974.2 | 43.4 |
| 30 | 905.4 | 40.3 |
| 10 | 872.8 | 38.9 |
| 5 | 519.4 | 23.1 |
| 2 | 189.2 | 8.4 |
| 1 | 65.9 | 2.9 |

## Conclusion

Results revealed that the highest floods would occur every 200 years and the inundation area would be 1115.0 ha with a probability of 0.5%, followed by in every 100 years the inundation area would be 1086.2 ha with a probability of 1%, in every 50 years the inundation area would be 974.2 ha with a probability of 2% and so on and so forth and so on. The lowest floods will occur every year and inundation area would be 65.9 hectares with 99% probability. It is envisaged to overlay land use data and perform damage estimation of the study area in future studies.

## References

Sharma, R.K. (1979). Text book of Hydrology and water resources.

## Acknowledgements

Authors wish to thank CASITA project of ADPC, Thailand.