Environment & Ecology 27 (4) : 1537—1540, 2009
 ISSN 0970-0420

Rain Induced Flood Prone Area Identification in Nadia District, West Bengal Through GIS

SHIBAMOY DEY, SAON BANERJEE, ABHIJIT SAHA AND M. K. NANDA

Department of Agrometeorology and Physics, Bidhan Chandra Krishi Viswavidyalaya
Kalyani 741252, India
E-mail : sbaner2000@yahoo.com

Abstract

To identify the flash flood prone areas due to rainfall of Nadia district of West Bengal, historical rainfall data of five meteorological stations of the district were collected and rainfall at 50% probability level was worked out using incomplete gamma distribution. It is observed that during September and October the stations show two or more rainfall peaks which may cause the flash flood as during the end of monsoon antecedent soil moisture status is high causing high runoff. The thematic maps of mean rainfall, rainfall of the year 2000 and rainfall at 50% probability level were prepared. The thematic map of rainfall at 50% probability level has been used to demarcate flood prone zone of Nadia district.
Key words : Rainfall, Rainfall probability, Flood, Runoff, GIS.

In 2000, the severe occurrence of flash flood in the Nadia district of West Bengal, India is mainly caused by the shifting of rainfall pattern. Generally, the July and August months receive the maximum rainfall in the Gangetic plains of West Bengal. But recent trend is that the basin receives maximum rainfall during September and October. As soil moisture status changes continuously depending on precipitation (Tripathi and Singh 1990) and at the end of September, the stored soil moisture is high, a little increase of rainfall causes runoff. Even a typical graphical representation of rainfall and runoff relationship shows after a certain amount of rainfall, threshold value of runoff is obtained (Timothy and Thomas 1999). Threshold runoff is the runoff needed to initiate flooding. It is a fixed value based on the geographic and hydrologic features of the basin. Different workers have used the rainfall data for flood modeling in regional scale (Knebl et al. 2005). Here GIS can be used as a tool for environmental planning and natural resource management activities (Kopp 1996). Based on these a study was carried out to evaluate the weekly probability of rainfall in the study area and based on this to identify the flash flood prone areas for prioritization through GIS.

Methods

Collection of Weather Data

Nadia district of West Bengal, situated in the eastern side of the river Ganges is considered for the study (Fig. 1). Historical data (for last 16 years) of five meteorological stations namely Hanskhali (88.68^{0}E, 23.33^{0}N), Kaliganj (88.32^{0}E, 23.69^{0}N), Karimpur (88.64^{0}E, 23.93^{0}N), Nakashipara (88.44^{0}E,

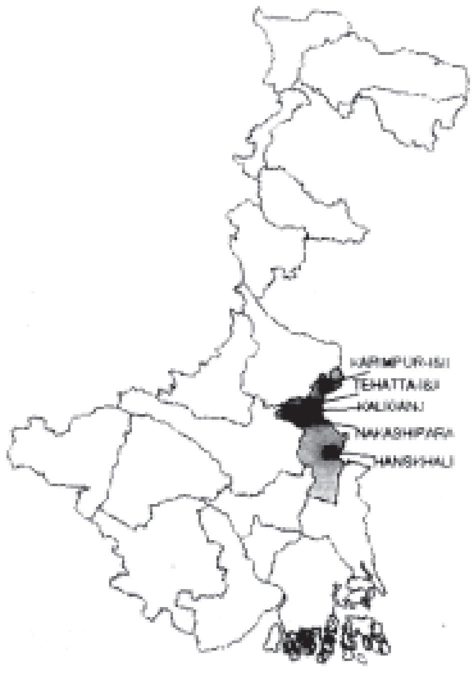

Figure 1. Position of rain gauge stations in the Nadia district, West Bengal, India.

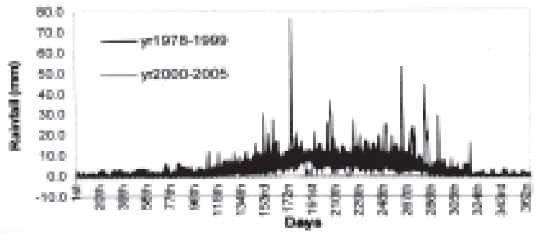

Figure 2. Comparison of rainfall between pre-2000 and post-2000 era.

23.61⁰N) and Tehatta (88.51⁰E, 23.75⁰N) were collected for the study. For observing the pattern of rainfall shifting, historical weather data of Kalyani observatory (1978—2005) were used.

Gamma-Distribution Analysis

To find out the mean weekly rainfall as well as rainfall at 50% probability level, incomplete gamma distribution (Thom 1966) was fitted with collected historical rainfall data for all the station except Kalyani.

GIS Mapping

To create digitized maps of spatial variation of mean rainfall and probabilistic rainfall, Map-Info Version 6.5 was used. The variation of 2000-rainfall is also shown in GIS environment find out rainfall-flood occurrence relationship.

Results and Discussion

Study on Rainfall Shifting Pattern

Graphical representation has shown several rain-

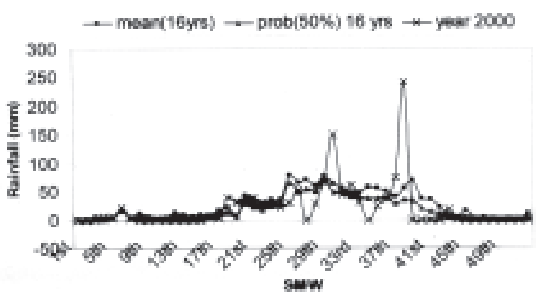

Figure 3. Variation of actual rainfall, 50% probability rainfall and rainfall in the year 2000 of Hanskhali.

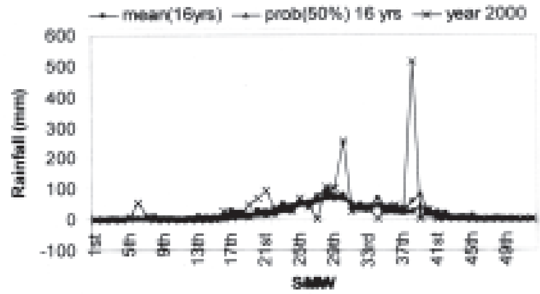

Figure 4. Variation of actual rainfall, 50% probability rainfall and rainfall in the year 2000 of Kaliganj.

fall peaks during September-October months (i.e. days 250 to 300 in a year) for the period of 2000 to 2005. On the contrary, for the period 1978 to 1999, no such rainfall peak occurred during those two months (Fig . 2), although in September a constant uniform amount of rainfall was observed, total monthly average of which is same with that of 2000—2005. It reveals that there is a peak-rainfall occurrence shifting which may be the cause of flash flood as during end of monsoon the antecedent soil moisture status is high causing high runoff rate.

Variation of Actual Rainfall and Rainfall at 50% Probability Level

The variation of actual rainfall and rainfall at 50% probability level for different standard meteorological week (SMW) of Hanskhali is shown in Figure 3. It is observed that during September and first fortnight of October (SMW 34 to 40), the mean rainfall is almost same with that of July-August rain. The rainfall

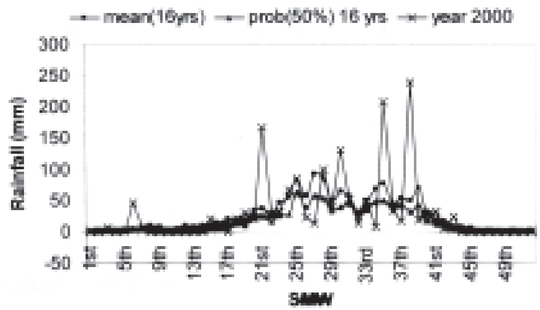

Figure 5. Variation of actual rainfall, 50% probability rainfall and rainfall in the year 2000 of Karimpur.

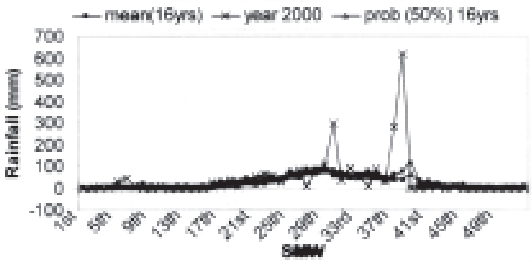

Figure 6. Variation of actual rainfall, 50% probability rainfall and rainfall in the year 2000 of Nakashipara.

at 50% probability level almost follows the same trend with mean rainfall not only in Hanskhali, but also in other areas i.e. Kaliganj (Fig. 4), Karimpur (Fig. 5), Nakashipara (Fig. 6) and Tehatta (Fig. 7). In all areas except Hanskhali, clear-cut rainfall peaks are observed at week 40. The rainfall data of the year 2000 was also plotted in the graphs (Figs. 3 to 7) for showing the difference between mean rainfall and rainfall of that year. Sharp peak of rainfall (amounting more than 200 mm) around SMW 40 is observed in almost all cases.

GIS Analysis for Thematic Mapping

Average rainfall of September and October of five geo-coded raingauge stations as stated earlier were put in GIS platform. According to average rainfall, thematic mapping of the zone was created. Thematic map of mean rainfall is shown in Figure 8 which depicts the spatial variation of mean historical rainfall record. The northern, southern and some of western parts of the district receives relatively less rainfall (< 300 mm) while the middle portion of the same receives more rainfall (> 400 mm). The thematic map of rainfall at 50% probability level has shown the similar trend (Fig. 9). The actual rainfall scenario of 2000 is little bit

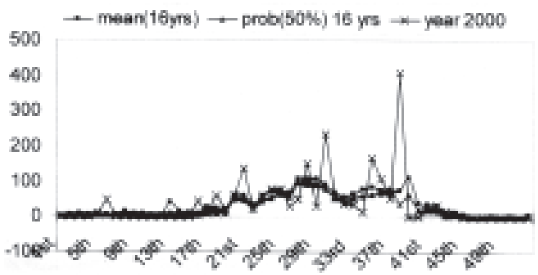

Figure 7. Variation of actual rainfall, 50% probability rainfall and rainfall in the year 2000 of Tehatta.

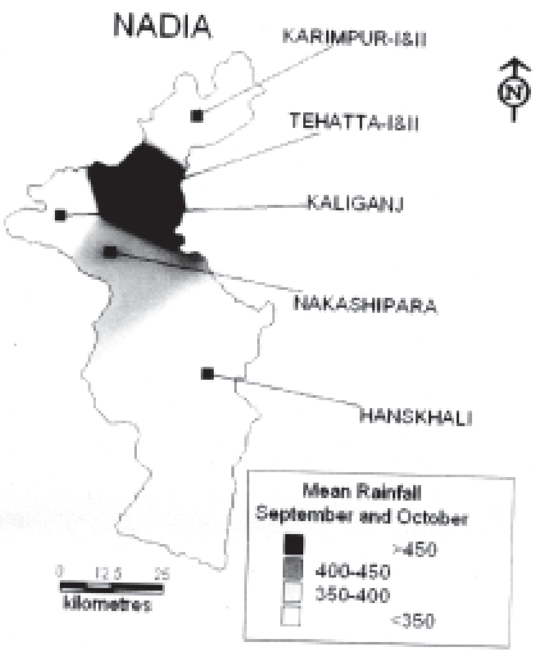

Figure 8. Thematic map of mean rainfall.

different and from the thematic map of 2000 rainfall data it is observed that in September and October months all corners of the district receives more than 350 mm of rainfall (Fig.10). The middle portion of the

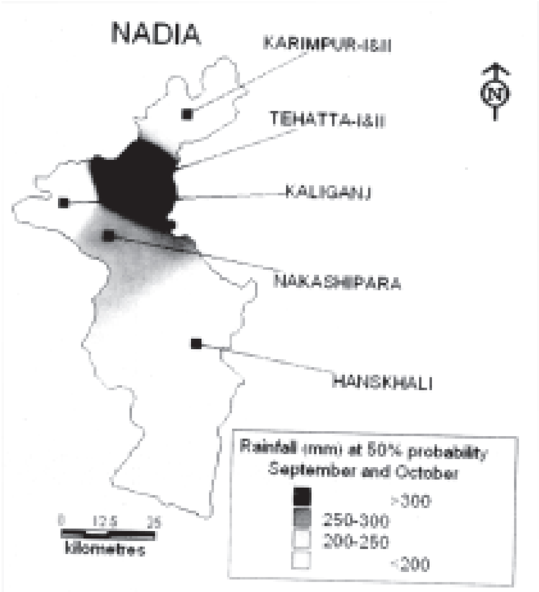

Figure 9. Thematic map of rainfall at 50% probability level.

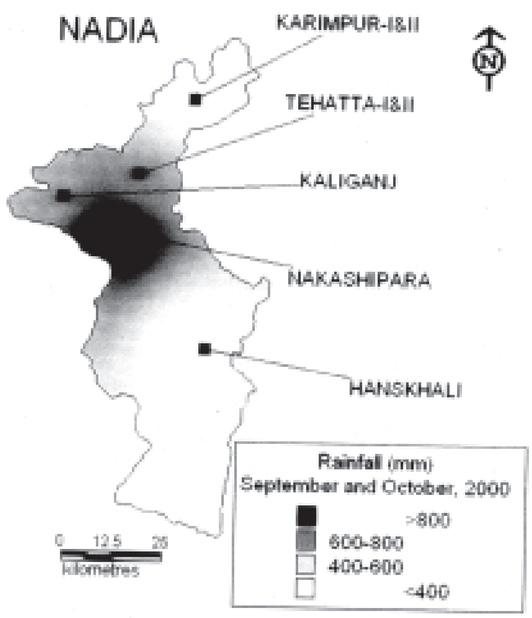

Figure 10. Thematic map of rainfall in the year 2000.

district receives higher rainfall and the area is matching well with worst flood-affected area.

Though the thematic map of rainfall at 50% probability level an attempt has been made to demarcate flood prone zone of Nadia district. It can be concluded that the middle portion of the district around Tehatta and Nakashipara is alarming zone for flash flood caused by late rains. In near future, the powerful interpolation algorithms should be adopted for prediction of not only flood extents but also flood depth maps using digital terrain data and surface elevation data points.

References

Knebl M. R., Z. L. Yang, K. Hutchison and D. R. Maidment. 2005. Regional scale flood modeling using NEXRAD rainfall, GIS, and HEC-HMS/RAS : A case study for the San Antonio River Basin Summer 2002 storm event. *J. Env. Manage.* 75 : 325—336.

Kopp S. M. 1996. Linking GIS and hydrological models : Where we have been, where we are going ? Hydro GIS 96. *Proc. of Vienna Conf.* Apr 1996. IAHS Publ. No. 235 : 133—139.

Thom H. C. S. 1966. Some methods of climatological analysis. WMO Tech. Note No. 81 : 20—22.

Timothy L. and F. Thomas. 1999. Modernized flash flood guidance. NOAA'S Nat. Weather Serv. http://www. weather.gov/oh/hrl/ffg/modflash.htm.

Tripathi R. P. and H. P. Singh. 1990. Pp. 53—57. *In Soil erosion and conservation.* Wiley Eastern Ltd., New Delhi, India.