ASSESSING THE FLOOD RISK AREA OF SOUTHERN THAILAND WITH AN INTEGRATED CURVE NUMBER AND FLOW ACCUMULATION APPROACH

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ABSTRACT: Land use/land cover and the area elevation are two major factors which play important roles in flooding. This paper aims to assess the flood risk area by integrating GIS-based analytical flooding model with a widely used SCS-Curve Number method. The simulated flood risk area of the southern peninsular of Thailand by comparing the flood occurred area detected by the satellite of 2011. Results show strong spatial connection between land use types and flood stage elevation. Therefore, land use planning should be addressed for flooding solution in southern Thailand to avoid lives and properties lost. Surface runoff occurs when the rate of precipitation exceeds the infiltration rate. This process is affected by factors associated with rainfall, including watershed characteristics, such as size, shape, topography and vegetation. There are a number of models for computing surface runoff in terms of runoff depth and runoff volume. The aim of this section is to investigate the influences of land use on surface runoff, the SCS Curve number method was selected to estimate the surface runoff in this study, as land use is one of the input factor use in this model.

1. INTRODUCTION

In the past few years, flooding has become the serious problem of Thailand. Five southern provinces were flooded three times last year due to the unusual rainfall. According to the Disaster Prevention and Mitigation Department, Thailand (2011), last year Severe flooding in southern provinces in Thailand has killed 59 people, totally destroyed nearly 400 homes, and damaged several roads and 1.1 million rai (176,000 hectares) of farmland and left nearly 500 thousand people in vulnerable, especially the people who living on the low land. The affected flooded area included Chumporn, Trang, Phatthalung, and Nakorn Si Thammarat where was the hardest-hit.

High rainfall is the area characteristic of the southern peninsular of Thailand. The average annual rainfall of the south is about 2000 mm which over the average annual rainfall of the country (1,560 mm) (Pongkrit, 1992). Due to the high rainfall rate cause the southern part of Thailand has high risk to the flooding and together with the land use characteristic and the topography, some parts of the area can frequently face to the flooding incident every year.

Flooding is expected to be increased due to the climate change and the area utilization, the assessment tools to locate the flood risk area are needed in order to minimize the unexpected effects. This study attempted to assess the flood risk level of the southern part of Thailand focusing at Nakorn Si Thammarat watershed as it was the focal point of previous serious flood. The assessment method tried to integrate the physical characteristic i.e. topography with soil, land use and land cover characteristics of the area.

2. MATERIALS AND METHOD

2.1 The study area

This study conducted at Nakorn Si Thammarat watershed, a part of Nakorn Si Thammarat Province which located on the southern peninsular of Thailand. This area had several times flooding incidents, left hundreds thousands of people living with vulnerability. Most of the watershed is low land area with occupied by the rice field, the west part of the watershed has hill type of landform which cover mostly by the economic perennial trees e.g. rubber plantation, oil palm plantation (Figure 1).

Figure 1 The study area

2.2 The integration of flow accumulation and SCS Curve number method

The land utilization and the soil characteristic are the major factor causing the amount of surface runoff whereas the topography can determine the water accumulation. By integrating the amount of surface runoff of the area to the area elevation or topography can help estimating the risk level of water accumulation and finally the flood risk level.

There are numerous of hydrological models to assess the flood risk area. The model used in this study to estimate runoff is the USDA Soil Conservation Service (SCS) Runoff Curve Number (CN) method (USDA, 1972). The model estimates runoff from rainfall and land use.

2.3 The SCS Curve Number Method

Surface runoff occurs when the rate of precipitation exceeds the infiltration rate. This process is affected by factors associated with rainfall, including watershed characteristics, such as size, shape, topography and vegetation. The aim of this section is to investigate the influences of land use on surface runoff, the SCS Curve number method was selected to estimate the surface runoff in this study, as land use is one of the input factor use in this model.

The value of Curve Number (CN) is a function of soil hydrologic conditions, land use, and infiltration characteristics of soils. Runoff depth was computed using Equation 5.2 and 5.3 and runoff volume was computed using Equation 5.4.

$$q = \frac{(P-0.2S)^2}{(P+0.8S)} \qquad \text{(Equation 1)}$$

where, q = Runoff depth (cm); P = Rainfall (cm), S = Retention parameter which represents the antecedent moistures, soil condition, land use, and conservation practice. It can be derived from:

$$S = \left(\frac{2540}{CN}\right) - 25.4 \qquad \text{(Equation 2)}$$

where, CN = Curve number. The CN value was estimated based on soil type and antecedent moisture conditions (AMC), and land use types.
The elevation, soil condition and land use type were considered as the major factors on flooding in this study, the research framework was shown in Figure 2.

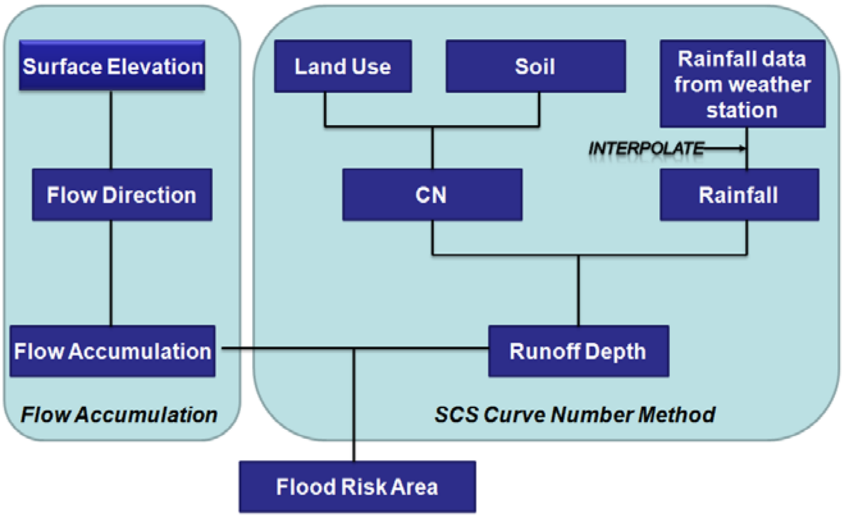

Figure 2 The flood risk area assessment by integrating the flow accumulation and SCS Curve Number method

3. RESULTS AND DISCUSSION

3.1 Level of water accumulation

Flow accumulation usually used to determine the drainage of the watershed, this study applied its concept to investigate the area where the water accumulation process occurred as this can cause the water logging on the area.

Area elevation used to derive the digital elevation models (DEMs) and to create flow direction and accumulated flow. After conducting the flow accumulation by using the elevation data of the study area and the average 30-year rainfall data, the results described the area prone to the accumulation of the water or the surface runoff, it can be classified into 5 levels (Table 1). About 30% of the total area fallen into the very low of water accumulation while nearly 20% was in the low, moderate and high level of water accumulation. Only 7.5% of the total area has very high level of water accumulation.

Table 1 Area under different level of water accumulation

Level	Area (Hectare)	% of total area
Very low	2,559	33.7
Low	1,430	18.8
Moderate	1,530	20.1
High	1,512	19.9
Very high	572	7.5
Total	7,603	100

The area where indicated as high level of water accumulation can have high risk of water logging or finally flooding. Therefore, the utility of land where fallen under high level of accumulation should be aware of flooding incident which may occurred.

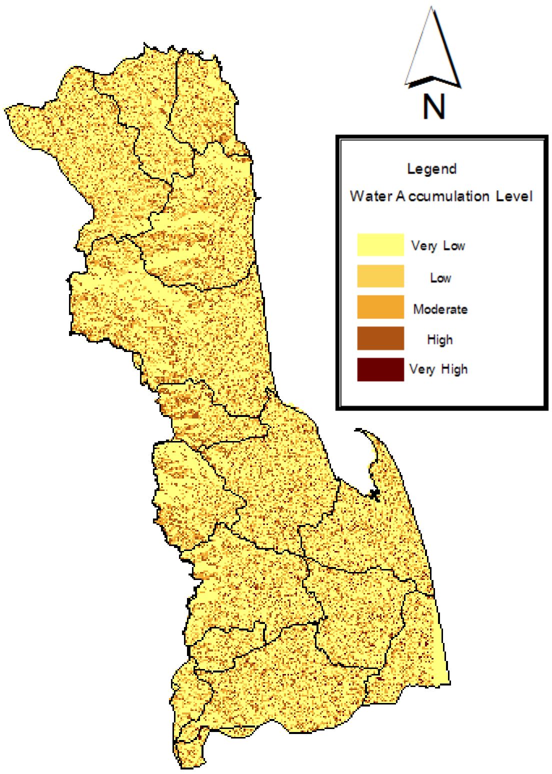

Figure 3 The are under different water accumulation level

3.2 The flood risk area estimated from the average 30-year rainfall

Flooding is very much depending on the land use type such as agriculture, residential and cities can cause high surface runoff due to the low water infiltration rate. Therefore, the SCS-Curve Number method was used to assess flooding in this study as it considered the land use and soil type as the major factor causing level of surface runoff.

The flood risk level presenting in Figure 4 was computing by using the average 30-year rainfall which the average annual rainfall was about 1,400-1,600 mm. The assessment results were classified into 5 categories. Due to the average rainfall, most of the area (94.4%) has very low risk of flooding, whereas low, moderate, high and very high level was 3.4%, 1.3%, 0.2% and 0.6% respectively.

The area of high and very high risk of flooding was mostly found in the low land area with the perennial type of land use than the area under rice cultivation or wetland and aquaculture.

Table 2 Area of different flooding severity level

Level	Area (Hectare)	% of total area
Very low	7,181	94.4
Low	258	3.4
Moderate	100	1.3
High	17	0.2
Very high	47	0.6
Total	7,603	100

Last years, the flooding of the study area happened 3 times due to the unusual rainfall, the annual rainfall of 2010 was more than 2,000 mm (TMD, 2011). Therefore; the area under high and very high flooding risk levels could have high potential facing the flooding if the rainfall exceeds the usual average rate.

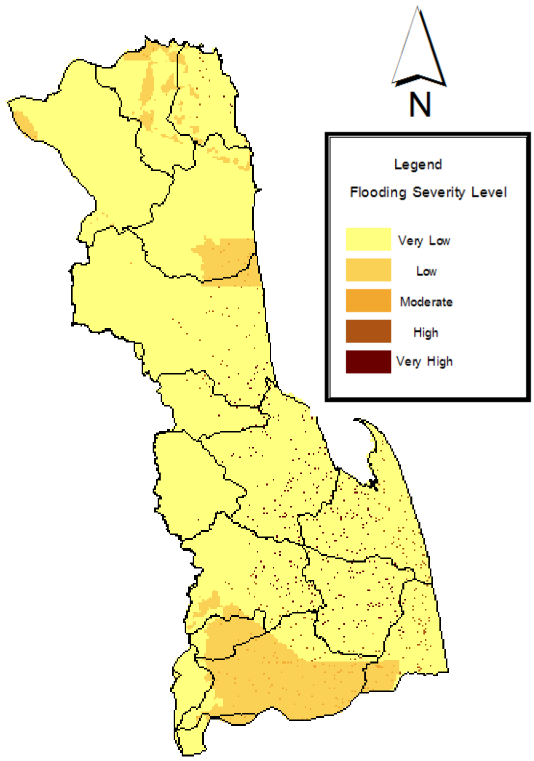

Figure 4 The flooding severity area

4. CONCLUSION

In this study, the assessment of flood risk area was used the combination of the topography and the land characteristics e.g. Land use, soil type. The main advantage of this proposed methodology was the combination of two major factors was taken into account i.e. topography and land and land use characteristics. The results showed that flooding of the area is inevitable to the topography.

This methodology can be improved to estimate the risk area due to the possible surface runoff which can help decision making for design for flood protection structures, for example, the open channels or the drainage system should be taken into consideration, in order to reduce the consequences of flooding.

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