# Flood Susceptibility Mapping Using Frequency Ratio (FR) and Shannon's Entropy (SE) Models in Nagavathi Sub-Basin, Tamlnadu India

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**Abstract:** In a few Watershed management studies, separation of flood prone region is being one of the main key tasks. Flood management is required to ease of the flood consequences in human lives and livelihoods. In the present study is to review and compare flood vulnerability maps produced using two statistical GIS-based topologies FR and SE models in the Nagavathi sub-basin, Tamil Nadu, India. In total, 29 flood locations were noted in the survey area. Out of these, 20 (70%) floods were approximately selected as training statistics and the remaining 9 (30%) floods had been used for the purposes of validation. Moreover, flood conditioning factors like lithology, land-use, distance from rivers, soil depth, rainfall, slope angle, slope aspect, curvature, topographic wetness index (TWI) and elevation were equipped from the spatial orientation. After that, the receiver Operating Characteristic (ROC) curves have been drawn for orgin flood vulnerability maps and the area beneath the curves (AUCs) was reckoned. The final consequences imply that the FR (AUC = 79.40%) and SE (AUC = 78.70%) models have almost analogous and practical outcomes. Consequently, these flood vulnerability maps can be valuable for analyzers and plotter in flood moderation strategies.

**Key Words:** Frequency Ratio, Shannon's Entropy, Flood Mapping, South India

## 1. INTRODUCTION

Flood screw ups have increased worldwide over the past 30 years, but over ninety % of all human deaths and extra than half of the monetary damages because of floods befell in Asia. Floods can may be defined because of heavy rainfall and snowmelt that overflow into rivers and flood plains, quickly overlaying the surrounding location (Kron 2002). It could purpose damage to transportation, cultural heritage, environmental ecosystems, agriculture, bridges, economic system, and human existence (Yu et al. 2013). Herbal elements which include hydrological and meteorological traits, soil sorts, geological structures, geomorphology, and flora are the most influential members to flooding. Human interference in herbal cycles by means of slicing trees and constructing with impervious materials can accelerate flooding. From sustainable improvement factor of view, the flood chance control is very critical for future (Esteves 2013; Schober et al. 2015).

Lee et al. (2012a) implemented Frequency Ratio (FR) model for flood vulnerability mapping in Busan, South Korea. The outcomes showed that FR version is very powerful for flood susceptibility modeling. Shannon's entropy (SE) is the average volatility in a random variable, which is equivalent to its statistics content material. The entropy of flood refers to the quantity that the various controlling flood occurrences influence the flood vulnerability. Numerous influencing elements give more entropy into the index method. Therefore, the entropy value may be used to calculate goal weights of the index system (Jaafari et al. 2014). The main objective of the present studies become to evaluate and compare flood vulnerability maps produced the use of statistical GIS-based strategies, i.e. FR and SE models within the Nagavathi sub-basin.

# 2. STUDY AREA

The study area of Nagavathi sub-basin lies in between 11°91'19" to 12°17'91" northern Latitude and 77°89'06" to 78°13'70" eastern Longitude and covering an area of approximately 420 sq. km. It is covered in the Survey of India toposheet numbers 57 L/4, 57H/16, 58 I/1, 58 E/13 on 1:50,000 scale. The important towns and villages within the look at area are Sirugalur, Adagappadi, Tadangam, Gorapuliyankottai, Alamarttur and Kombadiyur etc. Network of transport facilities are available through metalled roads in all the seasons. The area chosen for the current study is the Nagavathi river basin sub basin of river, which comes under the precambrian province (Figure 1).

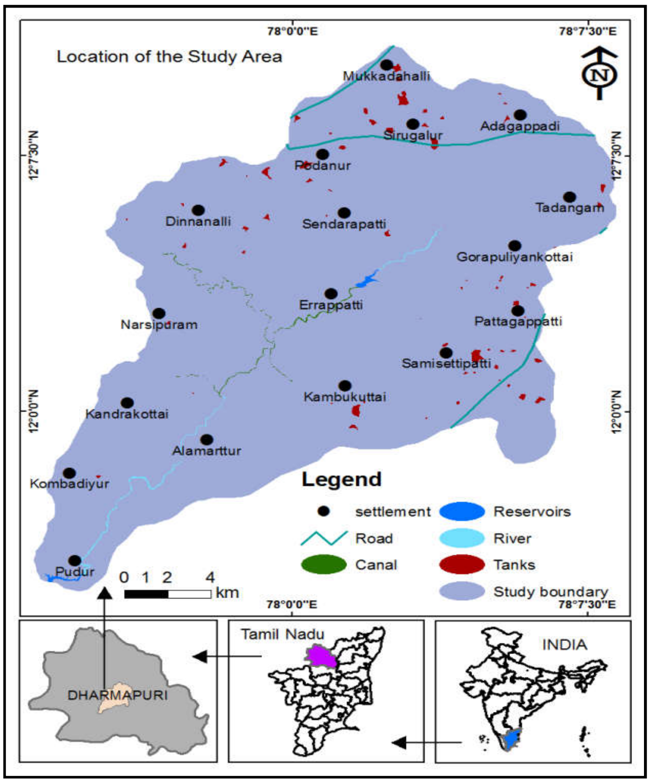


Figure 1 Location of the Nagavathi sub-basin

# 3. METHODOLOGY

### 3.1 Identify Flood Locations

A basin stage flood-prone region map presents the regional level planners and selection makers with facts beneficial in formulating extensive rules to guide the future improvement of flood plains. within the context, the flood-prone map become organized using SRTM satellite tv for pc records were carried out to create a digital elevation model (DEM) of the take a look at region with spatial resolution of 90 m. The slope and contour maps had been prepared the use of DEM. Which include contour traces with 20 m interval connecting points at the ground surface that have the same elevation showing the configuration and elevation of the land surface. The regions situation to flooding has been delineated from without problems available records for short appraisal rather than with the aid of designated discipline surveys.

### 3.2 Flood Conditioning Factors

On the way to execute flood vulnerability mapping it's miles essential to discover the flood conditioning elements (Kia et al., 2012). Consequently, a flood related spatial database must be created. Via the knowledge accrued from the literature review and discipline research the conditioning elements have been selected (Smith and Ward, 1998). Hence, ten flood conditioning factors which includes lithology, land use / land cover (LULC), soil intensity, distance from principal river, rainfall, altitude, curvature, slope, topographic wetness index (TWI) and component had been selected for the vulnerability analysis and the spatial database of those factors become compiled.

#### 3.2.1 Lithology

The lithology is considered as one of the most essential indicators of hydro-geological features which play a essential function in each the porosity and permeability of aquifer substances (Ayazi et al., 2010). Consistent with Geological Survey of India the lithology of the take a look at location is varied and protected by way of six rock types. It is directly or indirectly related with flood regions. The statistical analyses had been accomplished of the FR and SE for lithological factors (table 1). From the outcomes, the spatial distributions of FR and SE maps become prepared for integration.

#### 3.2.2 Land use / Land cover

Land use types play a great position, which directly or indirectly have an effect on some of hydrological techniques additives together with infiltration, evapotranspiration and runoff technology. Build-up regions, which are in the main made by way of impervious surfaces, increase the storm run-off and inundation (Shafapour Tehrany et al. 2013). However, agricultural areas are much less at risk of flooding due to affirmative relationship among infiltration ability and vegetation density. The statistical analyses have been performed of the FR and SE. From the outcomes, the spatial distributions of FR and SE maps become prepared for integration.

#### 3.2.3 Soil order

Soil is one of the maximum critical elements inside the surface and subsurface runoff era and infiltration process (Mogaji et al., 2014). The statistical analyses had been achieved of the FR and SE. From the outcomes, the spatial distribution of FR and SE maps changed into organized for integration.

#### 3.2.4 Distance from main rivers

Distance from major rivers play giant roles in hydro-geological systems. it's far one of the primary conditioning elements because of its impact at the flood value (Glenn et al. 2012). The closeness of the slope to drainage structures is another important thing in terms of stability. Streams may additionally adversely affect stability by eroding the slopes or with the aid of saturating the decrease part of material till ensuing in water altitude increases (Gokceoglu and Aksoy 1996). The distance from river map became produced the usage of the buffer device in ArcGIS and became labeled into five classes (Fig.6.8). The statistical analyses have been acheived of the FR and SE. From the consequences, the spatial distribution of FR and SE maps was organized for integration.

### 3.2.5 Rainfall (Rf)

The monsoon flooding takes vicinity after heavy rain, so this component must be considered as one of the essential members in flood prevalence (Bajabaa et al., 2013). Common annual rainfall in the study region varies in the range of 856 mm. The statistical analyses have been achieved of the FR and SE. From the outcomes, the spatial distribution of FR and SE maps changed into organized for integration.

### 3.2.6 Altitude

Special altitudes have altered climate conditions, and this induced variations in soil situation and plants type (Aniya, 1985). The statistical analyses have been performed of the FR and SE. From the outcomes, the spatial distribution of FR and SE maps turned into prepared for integration.

### 3.2.7 Curvature

Describe the altering rate of the slope on the versant profile route, respective alongside the float alignments, perpendicular to the altitude curves. To put it in any other case, it suggests the slope variation in vertical plan (Smith et al., 2012). Shary (1995) and Florinsky (1998) call it vertical curvature negative values for curvature ($<-2$) correspond concave and accumulation zones, zero values for curvature represent the flat and transitional zones and the wonderful values for curvature constitute the convex and dissipation zones (Florinsky 2000). Curvature, (Tc) became calculated from the DEM. The map comprises five classes starting from very high class to very low magnificence. The curvature map changed into grouped into 5 instructions including (-1.05--zero.21), (-zero.21-0.06), (-zero.06-0.06), zero.06-0.25 and 0.25-1.35 (Fig.6.15). The statistical analyses have been achieved of the FR and SE. From the outcomes, the spatial distributions of FR and SE maps become prepared for integration.

### 3.2.8 Slope angle

Slope is one of the important parameter to control floods. Primarily based on the quantile category scheme (Tehrany et al. 2014), the slope angle map was grouped into six classes such as <7°, 7°-15°, 15°-20°, 20°-25°, 25°-30° and >30° (Fig.6.18). The statistical analyses have been accomplished of the FR and SE. From the effects, the spatial distributions of FR and SE maps become organized for integration.

### 3.2.9 Topographic Wetness Index (TWI)

Topographic Wetness Index (TWI) has been extensively used to give an explanation for the impact of topography conditions at the place and size of saturated source zones of surface runoff generation. It is defined as (Moore et al. 1991):

$$TWI = In\left(\frac{A_s}{tan\beta}\right) \quad (1)$$

Where, $A_S$ is the cumulative upslope area draining through a point (per unit contour length) and β is the slope gradient (in degree). In this study, TWI map is grouped into 5 classes the use of quantile category scheme (Tehrany et al. 2014). The tendency of water to build up at any factor in the catchment (in terms of α) and the tendency of gravitational forces to move that water down slope (indicated in terms of tan b as an approximate hydraulic gradient) are considered through the ln β tanα index.

Usually, the water infiltration depends upon material properties like permeability and pours water strain at the soil strength. The statistical analyses had been finished of the FR and SE. From the outcomes, the spatial distribution of FR and SE maps turned into organized for integration.

**3.2.10 Aspect**

Aspect is associated with the principle precipitation direction and the physiographic trends (Ercanoglu and Gokceoglu 2002). Slope issue layer turned into extracted from DEM and divided into 9 classes such as ten directions and flat based on normal or common standard classification. The statistical analyses had been performed of the FR and SE. From the consequences, the spatial distribution of FR and SE maps turned into prepared for integration.

**3.3 Frequency Ratio (Fr) Model**

Frequency ratio (FR) model is a bivariate statistical method which can be used as a useful geospatial evaluation device to decide the probabilistic correlation between structured and impartial variables, together with multi-categorized maps (Oh et al. 2011). Lately, FR model has been effectively used for flood vulnerability mapping by using Tehrany et al. (2014a), Rahmati et al. (2015). In fact, the FR is defined as the ratio of the region in which flood occurred inside the total study region. FR model structure is primarily based on the correlation and found relationships between every flood conditioning issue and distribution of flood places. FR value in every magnificence of the groundwater-associated element may be expressed based totally on Eq. 2:

$$FR = \left(\frac{A/B}{C/D}\right) \qquad (2)$$

**3.4 Shannon's Entropy Model**

The entropy index is a degree of "evenness" extent to which organizations are lightly dispensed among organizational units (Massey and Nancy 1988). Within the present study, an attempt has been made to evaluate flood vulnerability mapping the use of entropy. More exactly, Theil (1972) described entropy index as a measure of the average distinction among a unit's group proportions and that of the system as an entire. There's a one-to-one relationship among the quantity of entropy of a system and the degree of disorder called Boltzmann principle and has been used to represent the thermodynamic status of a system (Yufeng and Fengxiang 2009). Shannon enhanced upon the Boltzmann principle and established an entropy model for information theory. The equations carried out to calculate the information coefficient (Vj) representing the load value for the parameter as an entire (Bednarik et al. 2010) are given as following (Eqs. 3–7):

$$E_{ij} = \frac{FR}{\sum_{j=1}^{M_j} FR} \qquad (3)$$

Wherein, FR is the frequency ratio and Eij is the chance density.

$$H_j = -\sum_{i=j}^{M_j} E_{ij} Log_2\ E_{ij}, j = 1, \ldots., n \qquad (4)$$

$$H_{jmax} = log_2 M_j, \qquad M_j = number\ of\ classes \qquad (5)$$

$$I_j = \left(\frac{H_{jmax} - H_j}{H_{jmax}}\right), I = (0,1), j = 1, \ldots_n \quad (6)$$

$$V_j = I_j FR \quad (7)$$

Where, $H_j$ and $H_{jmax}$ are entropy values;

$I_j$ is the information coefficient and

$M_j$ is the number of classes.

Vj depicts the resultant load value for the parameter as a entire

Table 1 FR and SE value calculations

| **Lithology** | No. of pixel in domain | Percentage of domain | No. of well | Percentage of well | FR | Eij | Hj | Hmax | Ij | Vj | Vj final |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gneiss | 17344 | 47.757 | 14 | 48.276 | 1.01 | 0.212 | 0.679 | 0.778 | 0.128 | 0.129 | 0.610 |
| Charnockite | 13503 | 37.181 | 10 | 34.483 | 0.93 | 0.194 | | | | | |
| Basic rocks | 100 | 0.275 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| Migmatitic complex | 715 | 1.969 | 1 | 3.448 | 1.75 | 0.367 | | | | | |
| Anorthosite | 4630 | 12.749 | 4 | 13.793 | 1.08 | 0.227 | | | | | |
| Tanks/Reservoirs | 25 | 0.069 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| **Land use land cover (LULC)** | | | | | | | | | | | |
| Crop land | 19202 | 52.750 | 15 | 51.724 | 0.98 | 0.303 | 0.5106 | 0.7782 | 0.3438 | 0.3371 | 2.062 |
| Built-up land | 11038 | 30.323 | 8 | 27.586 | 0.91 | 0.281 | | | | | |
| Reserved forest | 5577 | 15.321 | 6 | 20.690 | 1.35 | 0.417 | | | | | |
| River | 14 | 0.038 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| Water bodies | 280 | 0.769 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| Fallow land | 291 | 0.799 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| **Soil Depth (Sd)** | | | | | | | | | | | |
| Reserved forest | 5579 | 15.345 | 2 | 6.897 | 0.45 | 0.081 | 0.744 | 0.7782 | 0.0438 | 0.0197 | 0.262 |
| Hill soil | 282 | 0.776 | 0 | 0.000 | 0.00 | 0.00 | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | | | | |
| Entisols | 13802 | 37.962 | 9 | 31.034 | 0.82 | 0.147 | | | | | |
| Inceptisol | 1621 | 4.459 | 2 | 6.897 | 1.55 | 0.279 | | | | | |
| Vertisols | 891 | 2.451 | 1 | 3.448 | 1.41 | 0.254 | | | | | |
| Alfisols | 14182 | 39.008 | 15 | 51.724 | 1.33 | 0.239 | | | | | |
| **Distance from river (Dfr) m** | | | | | | | | | | | |
| <200 | 1623 | 4.600 | 2 | 6.897 | 1.50 | 0.302 | 0.6962 | 0.699 | 0.0039 | 0.0059 | 0.019 |
| 200-400 | 1535 | 4.351 | 1 | 3.448 | 0.79 | 0.159 | | | | | |
| 400-600 | 1447 | 4.101 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| 600-800 | 1380 | 3.912 | 2 | 6.897 | 1.76 | 0.355 | | | | | |
| >800 | 29295 | 83.036 | 22 | 75.862 | 0.91 | 0.184 | | | | | |
| **Raifall (Rf)** | | | | | | | | | | | |
| 815 - 837 | 3672 | 10.234 | 4 | 13.793 | 1.35 | 0.301 | 0.6517 | 0.699 | 0.0676 | 0.0911 | 0.337 |
| 837- 852 | 20001 | 55.746 | 18 | 62.069 | 1.11 | 0.249 | | | | | |
| 852- 870 | 4515 | 12.584 | 3 | 10.345 | 0.82 | 0.183 | | | | | |
| 870- 891 | 2728 | 7.603 | 1 | 3.448 | 0.45 | 0.101 | | | | | |
| 891- 911 | 4963 | 13.833 | 3 | 10.345 | 0.75 | 0.167 | | | | | |
| **Altitute (At)** | | | | | | | | | | | |
| 236 - 352 | 4688 | 9.365 | 6 | 20.690 | 2.21 | 0.457 | 0.6839 | 0.699 | 0.0216 | 0.0477 | 0.107 |
| 352 - 417 | 9274 | 18.527 | 4 | 13.793 | 0.74 | 0.154 | | | | | |
| 417 - 465 | 18540 | 37.038 | 5 | 17.241 | 0.47 | 0.096 | | | | | |
| 465 - 592 | 17138 | 34.237 | 14 | 48.276 | 1.41 | 0.292 | | | | | |
| 592 - 880 | 417 | 0.833 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| **Total Curvature (Tc)** | | | | | | | | | | | |
| (-1.05--0.21) | 2392 | 4.779 | 0 | 0.000 | 0.00 | 0.000 | 0.6596 | 0.699 | 0.0563 | 0.000 | 0.281 |
| (-0.21-0.06) | 8568 | 17.116 | 8 | 27.586 | 1.61 | 0.353 | | | | | |
| (-0.06-0.06) | 28855 | 57.644 | 14 | 48.276 | 0.84 | 0.18 | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 3 | | | | | |
| 0.06-0.25 | 8236 | 16.453 | 6 | 20.690 | 1.26 | 0.275 | | | | | |
| 0.25-1.35 | 2006 | 4.007 | 1 | 3.448 | 0.86 | 0.188 | | | | | |
| **Slope angle (Dgree) (Sad)** | | | | | | | | | | | |
| <7° | 43432 | 86.765 | 25 | 86.207 | 0.99 | 0.227 | 0.6401 | 0.7782 | 0.1774 | 0.1763 | 1.06 |
| 7°-15° | 5624 | 11.235 | 3 | 10.345 | 0.92 | 0.211 | | | | | |
| 15°-20° | 704 | 1.406 | 1 | 3.448 | 2.45 | 0.561 | | | | | |
| 20°-25° | 216 | 0.432 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| 25°-30° | 78 | 0.156 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| >30° | 3 | 0.006 | 0 | 0.000 | 0.00 | 0.000 | | | | | |
| **Tophographic wetness index (TWI)** | | | | | | | | | | | |
| (-3.78-5.39) | 25726 | 51.393 | 8 | 27.586 | 0.54 | 0.080 | 0.8257 | 0.7782 | -0.0611 | -0.0328 | -0.36 |
| 5.39-7.37 | 5476 | 10.940 | 8 | 27.586 | 2.52 | 0.377 | | | | | |
| 7.37-9.08 | 8997 | 17.974 | 5 | 17.241 | 0.96 | 0.143 | | | | | |
| 9.08-11.06 | 8479 | 16.939 | 7 | 24.138 | 1.43 | 0.213 | | | | | |
| 11.06-19.25 | 1379 | 2.755 | 1 | 3.448 | 1.25 | 0.187 | | | | | |
| **Slope aspect (Sa)** | | | | | | | | | | | |
| Flat (-1) | 55 | 0.110 | 0.00 | 0.00 | 0.00 | 0.000 | 0.9961 | 1.000 | 0.0039 | 0.0000 | 0.039 |
| North (0-22.5) | 2669 | 5.332 | 3.00 | 10.34 | 1.94 | 0.196 | | | | | |
| Northeast (22.5-67.5) | 4715 | 9.419 | 2.00 | 6.90 | 0.73 | 0.074 | | | | | |
| East (67.5-112.5) | 6035 | 12.056 | 5.00 | 17.24 | 1.43 | 0.144 | | | | | |
| Southeast (112.5-157.5) | 7982 | 15.946 | 2.00 | 6.90 | 0.43 | 0.044 | | | | | |
| South (157.5-202.5) | 6389 | 12.763 | 3.00 | 10.34 | 0.81 | 0.082 | | | | | |
| Southwest (202.5-247.5) | 5274 | 10.536 | 5.00 | 17.24 | 1.64 | 0.165 | | | | | |
| West (247.5- | 6318 | 12.622 | 3.00 | 10.34 | 0.82 | 0.08 | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 292.5) | | | | | | 3 | | | | | |
| Northwest (292.5-337.5) | 7797 | 15.576 | 4.00 | 13.79 | 0.89 | 0.089 | | | | | |
| North (337.5-360) | 2823 | 5.640 | 2.00 | 6.90 | 1.22 | 0.123 | | | | | |

# 4. RESULTS AND DISCUSSION

## 4.1 FR Model

In a given pixel, flood susceptibility index (FSI) can be decided through summation of pixel values in line with Eq. (8):

$$FSI = Li_{FR} + LULC_{FR} + Dmr_{FR} + SO_{FR} + Rf_{FR} + Sad_{FR} + Sa_{FR} + Tc_{FR} + TWI_{FR} + At_{FR} \quad (8)$$

Frequency Ratio strategies have been implemented to decide the extent of relationship between flood locations and conditioning elements. In trendy, the FR value of 1 shows a mean correlation between flood locations and effective elements (Pradhan 2010). If the FR value might be larger than 1, there may be a excessive correlation, and a decrease correlation equals to the FR value lower than 1 (Lee et al. 2012a). The evaluation of FR for the connection between flood location and lithology units indicates that gneissic rocks have the best FR value (1.01) have the most chance for flooding inside the observe region. The crop and forest cover have values of zero.98 and 1.35, respectively, indicating that the probability of flood occurrence in those land-use kinds may be very high. For distance from river inside the range 400-600 m and 200-400 m, there's a low possibility of flooding; in evaluation, distances within the range <200 m and 600-800 m have the very best values (1.50, and 1.76, respectively). These outcomes established that the flooding usually takes place close to the river bank and infrequently far from the rivers. The results of soil displayed that inceptisols, vertisols and alfisols have the very best value of FR (1.55, 1.41 and 1.33 respectively)

The slope angle suggests that class 15°–20° has the highest FR value (2.45), and other indicating a low probability which means flood incidence probability decreases with increasing in slope angle. In the case of slope factor, flood event is maximum considerable on north (0-22.5) (FR = 1.94) and southeast going through slopes (FR = 0.forty three), have the lowest abundance. Primarily based on the curvature, the (-0.21-0.06) shape has the highest FR value (1.61) shows that the most probability for flooding. That shape retains floor run-off for a longer period in particular at some stage in heavy rainfall. Therefore, it's far greater prone for flooding compared to the alternative shapes. Flood locations are more focused in regions with a TWI (5.39-7.37) (FR = 2.52) and altitude classes of 236-352 m (FR = 2.21). Within the case of altitude, analysis of FR values established that the flood incidence cannot arise inside the excessive elevation areas of the study region. Eventually, based on Equation (6.8), the very last flood susceptibility map received by means of the FR model is shown in Figure 2a.

## 4.2 SE Model

In flood susceptibility mapping, the entropy measures and displays the spatial association among the conditioning factors and flood occurrences. The flood susceptibility index may be decided via summation in keeping with Eq.9.

$$FSI = Li_{FR}0.610 + LULC_{FR}2.062 + Dmr_{FR}0.019 + SO_{FR}0.262 + Rf_{FR}0.337 + Sad_{FR}1.064 + Sa_{FR}0.039 + Tc_{FR}0.281 + TWI_{FR}0.367 + At_{FR}0.107$$

Based at the results received from the entropy, the LULC and slope represented highest flood susceptibility within the observe area (Vj final, 2.062, 1.064 respectively) displaying maximum flood susceptibility. The entropy values of distance from the river indicated fine influence in flooding. The evaluation of SE for the relationship between flood occurrence and slope angle indicated that positive impacts in flooding. Within the case of slope aspect and plan curvature, flat region had a sturdy positive correlation with flood prevalence. Eij values increases via increasing classes of TWI. Moore et al. (1991) said that TWI represents the impact of topography at the location and size of saturated source regions of surface run-off generation below the assumption of steady-state conditions and uniform soil properties. In the case of altitude, the very best weight (0.457) turned into for the variety of 236-352 m that has fine impact in flood incidence. Sooner or later, primarily based on Equation (6.9), the very last flood susceptibility map created by means of the SE model is shown in figure 2b.

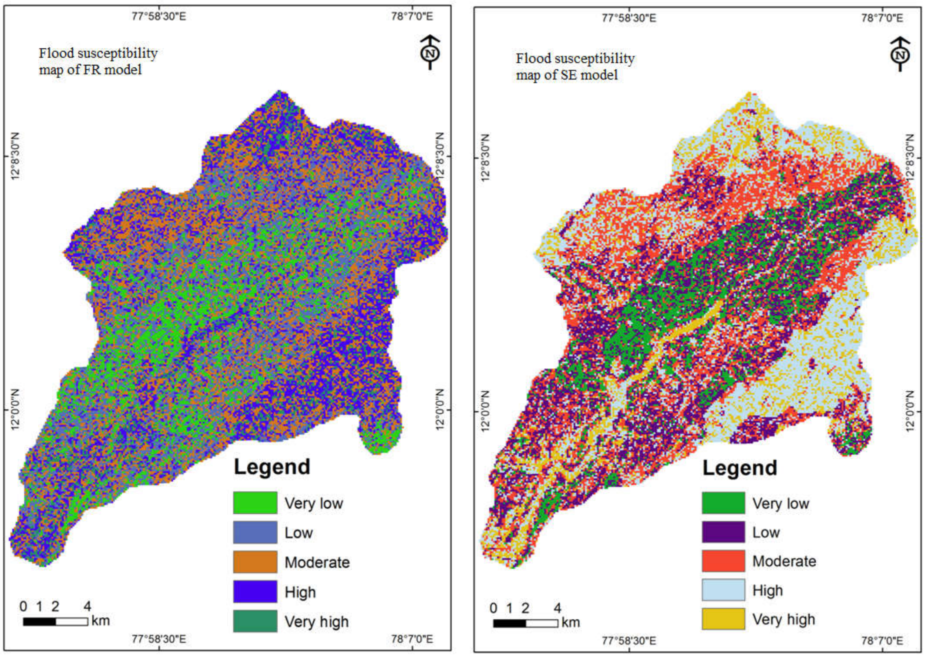


Figure 2 Flood susceptibility map of FR and SE model in Nagavathi sub-basin

### 4.3 Flood Susceptibility Validation

From scientific significance standpoint, validation is taken into consideration to be the maximum important procedure of modeling (Chung and Fabbri 2003). Therefore, it is very important to assess the ensuing Flood Susceptibility Index (FSI). The receiver operating characteristics (ROC) curve changed into carried out to decide the accuracy of the FSI. The FSI delineated inside the contemporary study became validated the usage of the flood locations. Primarily based on the flood inventory records, the accuracy evaluation of the flood susceptibility mapping became made. In overall, 29 flood locations had been mentioned in the study region. The ROC curves have been then acquired by way of considering cumulative percent of probability index maps (on the x axis) and the cumulative percent of flood occurrence (on the y axis).

The area under the curve (AUC) was calculated based on ROC curve evaluation and it demonstrates the accuracy of a prediction machine by using describing the system's capacity to anticipate an appropriate incidence or non-incidence of pre-described "events" (Jaafari et al. 2014). sooner or later, the usage of the quantitative and qualitative relationship among the AUC value and prediction accuracy can be grouped as very high, high, moderate, low and very low flood occurrences within the study region (Fig.3). In flood susceptibility appraisal, the main goal becomes to discover regions that may be stricken by future floods. Consequently, irrespective of which integration technique is used, it is very essential to validate the consequent flood susceptibility maps with appreciate to unknown future flood events (Chung & Fabbri 2003). In this observe, the flood locations that were no longer used during the model building/training have been used to verify the flood susceptibility maps. The receiver running characteristics (ROC) evaluation changed into used (Egan 1975; Swets 1988; Pradhan & Lee 2010; Pradhan et al. 2011; Pourghasemi et al. 2012a; Rahmati et al. 2014) to determine the accuracy of flood susceptibility maps produced the use of FR models. The ROC curve is a common method to decide the accuracy of a diagnostic test (Pourghasemi et al. 2012a), and it is taken into consideration as a graphical illustration of the trade-off between the false-negative (X-axis) and false-positive (Y-axis) rates for every possible cut-off value (Pourghasemi et al. 2014).

The AUC of ROC describes the accuracy of a prediction model with the aid of figuring out the system's ability to expect on the suitable incidence or non-incidence of pre-defined 'events' (Pourtaghi & Pourghasemi 2015). The ROC curves for FR and SE fashions are shown in determine 8 a & b respectively. It is clean that inside the flood susceptibility mapping the use of the FR model, the AUC is about 0.8020, which corresponds to the prediction accuracy of 80.20%, while in the flood susceptibility map using the SE model, the AUC is about 0.7930 and the prediction accuracy is 79.30%. Consequently, based on the calculated AUC, the FR and SE models indicated nearly similar and affordable consequences and can be used as simple tools in flood susceptibility mapping and flood mitigation when a sufficient number of datas are received (table 2).

Table 8.5 Areal extend of flood in the study area

| Model | Class | Flood pixel | % | No.of flood locations | % |
|---|---|---|---|---|---|
| **FR** | Very low | 4936 | 13.94 | 7 | 24.14 |
| | Low | 9581 | 27.06 | 8 | 27.59 |
| | Moderate | 10271 | 29.01 | 5 | 17.24 |
| | High | 7545 | 21.31 | 4 | 13.79 |
| | Very High | 3070 | 8.67 | 5 | 17.24 |
| **SE** | Very low | 4248 | 12.92 | 4 | 13.79 |
| | Low | 7940 | | 5 | 17.24 |
| | Moderate | 9532 | 29.00 | 6 | 20.69 |
| | High | 9820 | 29.87 | 6 | 20.69 |
| | Very High | 3863 | 11.75 | 8 | 27.59 |

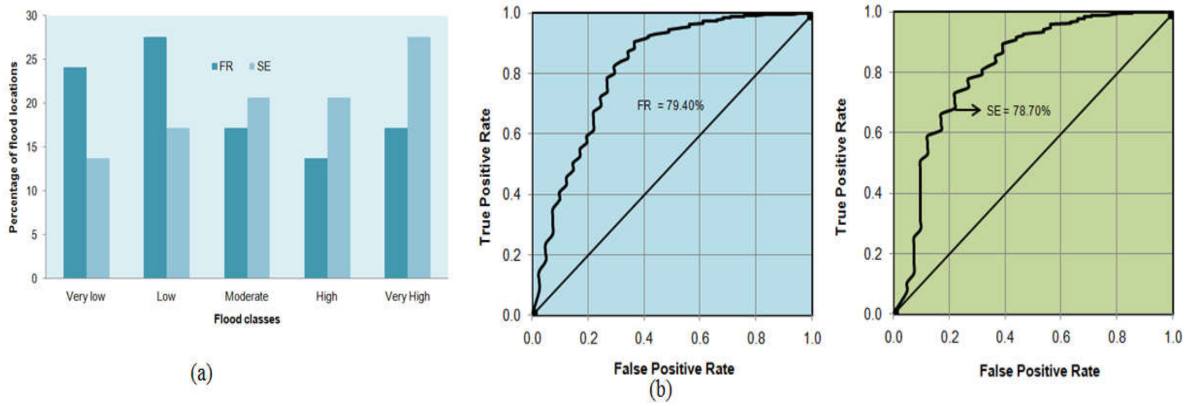


Figure 3 (a) Difference in flood classes (b) & (b) ROC curve for the flood susceptibility maps produced by FR & SE model

# 5. CONCLUSION

Industrial and agricultural expansion has been accompanied in recent decades by an ever increasing use of areas subject to flood, which has resulted in increased flood damages. Apart from studies related to investigations and improvements of river system, simultaneous action for studies of watersheds and adoption of measures aimded at runoff and water flow retardation is also required. Consequently, flood susceptibility mapping is important for integrated watershed management for you to have sustainable development. The validation of effects indicated that the FR and SE models had almost similar and reasonable results within the study region. In the present study, flood susceptibility maps had been organized using FR and SE methods with the integration of remote sensing and GIS. The application of the FR and SE models is divided into 3 steps: the construction of database, the calculation of weights and the data integration and verification procedure, wherein the obtained FSI turned into established with ROC and flood locations. In general, all used factors have incredibly better values of variant index implying the importance of all factors for correct demarcation of flood susceptible regions. FR approach is in agreement with the end result acquired by other researchers utilized in flood susceptibility appraisal and various environmental studies. FR model is effective and reliable approach for flood susceptibility mapping within the current study. According to Shannon's entropy results, it may be concluded that lithology and curvature have the most powerful relationships with flood incidence. Additionally, factors which include slope angle (degree) distance to from primary River, and slope component had the lowest significance on flood susceptibility map. From the evaluation, it is seen that the FR model (AUC=79.forty %) plays better than SE (AUC=seventy eight.30 %) models. As a final end, the results of the existing study proved that FR and SE models can be successfully used in flood susceptibility mapping. So, the end result of flood susceptibility map indicated that the Ponnaiyar river basin has undergone a considerable amount of the flood occurrences are made in future. Based on the overall assessments, the proposed methods on this observe had been concluded as goal and relevant. The scientific information derived from this observes can assist governments, planners and engineers to perform proper moves if you want to prevent and mitigate the flood prevalence in the future.

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