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# Statistical Analysis for Landslide in Relation to Landuse, InSirumalai Hill, Dindigul District, Tami Nadu, India, using GI Technologies

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## Abstract

*Landslide is among the major natural hazards that affect large parts of India, especially Western Ghats and Eastern Ghats. The paper presents a statistical approach through spatial data analysis in GIS with particular reference to land use pattern in Sirumalai Hill. This study to analysis the primary data with combined the engineering analysis method and ground validation to find the characteristics its spatial distribution in the study area. The present study uses sensitivity co-efficient to assess the effect of each land use category on landslide susceptibility. The analysis shows that the vulnerable category of land use is construction land and road, consisting of settlements and agriculture land and plantation. Hence from the study remote sensing and GIS techniques play a vital role in planning and evaluating disaster analysis.*

**Keywords:** Landslide, landsue, remote sensing and GIS, sirumalai, sensitivity coefficient.

## Introduction

Landslides constitute one of the major natural catastrophes, which account for considerable loss of life and damage to communication routes, human settlements, agricultural field and forest land. Slope failure is one of the major critical natural hazards. Geoscientist and land managers are more interested in landslide risk analysis and hill area development. Most of the terrain in mountainous areas has been subjected to slope failure under the influence of a variety of terrain factors and figured by events such as extreme rainfall or earthquake. Hence there is a need to landslide Hazard Zonation (LHZ) map for identification of potential landslide areas. In recent years several works have been carried out all over the world for LHZ mapping. Landslide Hazard zonation is a process of ranking different parts of an area according to the degree of actual or potential hazard from landslide[1,2]. The information models and fuzzy set theory applied this context[2]. The landslide susceptibility map depicts the distribution of potential unstable slope based on a given set of geo-environment[3,4]. The basic difference between these approaches lies in the assignment of numerical weights to the landslide causative factors[5].

The use of satellite images has removed some of the errors to some extent. Over the past few years, Remote sensing techniques integrated Geographic Information System (GIS) has gained significant importance for spatial data analysis[6,7,8]. The GIS technologies it has some possible to efficiently collect and manipulate the various data such as land use , geology, etc[9,10].

The present study is an attempt towards development of a methodology for different land use categories with their impact on landslides.

**Study Area:** Sirumalai is the eastern –most outcrop or spur of the Western Ghats and an independent range, and the Sirumalai range stretches about 45 km on the Dindigul- Madurai road with its width being about 15 – 25 km. There is no independent range in Tamil Nadu which is as big as with many comparable ranges in Tamil Nadu. The hill has a cool climate it is 1200 MSL meters high and spreads over 60,000 acres. On third of the area belongs private revenue land on which grows coffee, cardamom, black pepper, banana and lemon. The detail of study area information shows that (figure1).

Sirumalai is a small hill and is located in Dindigul district, Tamil Nadu, India his between 10° 07' N longitude and 77° 55' E longitude. They are an isolated, compact group of hills stretching about 6.5 km south of Madurai city. The hills are rectangular in outline, having 19.3 km length towards north south and 12.8 km width east-west, covering an area of 288.3sqkm. The maximum rainfall occurs during the monsoon months from April to September.

## Material and Methods

The different types of data sets used were as follows: i. Topographic maps of survey of India at 1:50,000 scale to from the base map. ii. Satellite Sensor data IRS LIIS IV with 5.8mtr resolution. iii. Field data involving observations on landslide and land use/land cover.

The sensitivity co-efficient ($SCL_i$) is most common quantification to evaluate landslide susceptibility to different landslide patterns. Different land use patterns generate diverse influences on slope instability (i.e) landslide susceptibility of various land use pattern present[11, 12]. Sensitivity co-efficient ($SCL_i$) is most common quantifying to evaluate landslide

susceptibility to different land use pattern[13, 14]. Sensitivity co-efficient is calculated as: Survey of India Toposheet updated Satellite imagery and field verification. All the topographic maps registered from an input into the GIS database

## Results and Discussion

**Landuse/ Lnadcover:** Landuse/Landcover is an important parameter for landslide susceptibility mapping. The Landuse/Landcover classes are identified which are as follows: forest cover, plantation, built-up area and water bodies are shown in figure 2. The IRS 1D LISS IV image data were classified using the unsupervised classification. The topographic maps, field data were used as a reference data. Finally unsupervised classification technique was used to prepare the land use / Landcover map. After preparing the map, it was again checked in field, we observe some errors. Finally the land use transferred to GIS. Most of the area covered by deciduous forest in (43.8%) waste land it's covered from 23.5% and Agriculture land it's covered from 20.1% in the total study area . The detail of land use classification shown in table 1.

**Table-1**
**Landuse /Landcover**

| Forest Types | 2005 | |
|---|---|---|
| | Area(sq.km) | Percentage |
| Forest | 126 | 43.8 |
| Water bodies | 8.3 | 2.8 |
| Agriculture land | 58 | 20.1 |
| Wasteland | 67.7 | 23.5 |
| Built-up | 28 | 9.7 |
| Total Area | 288 | 100 |

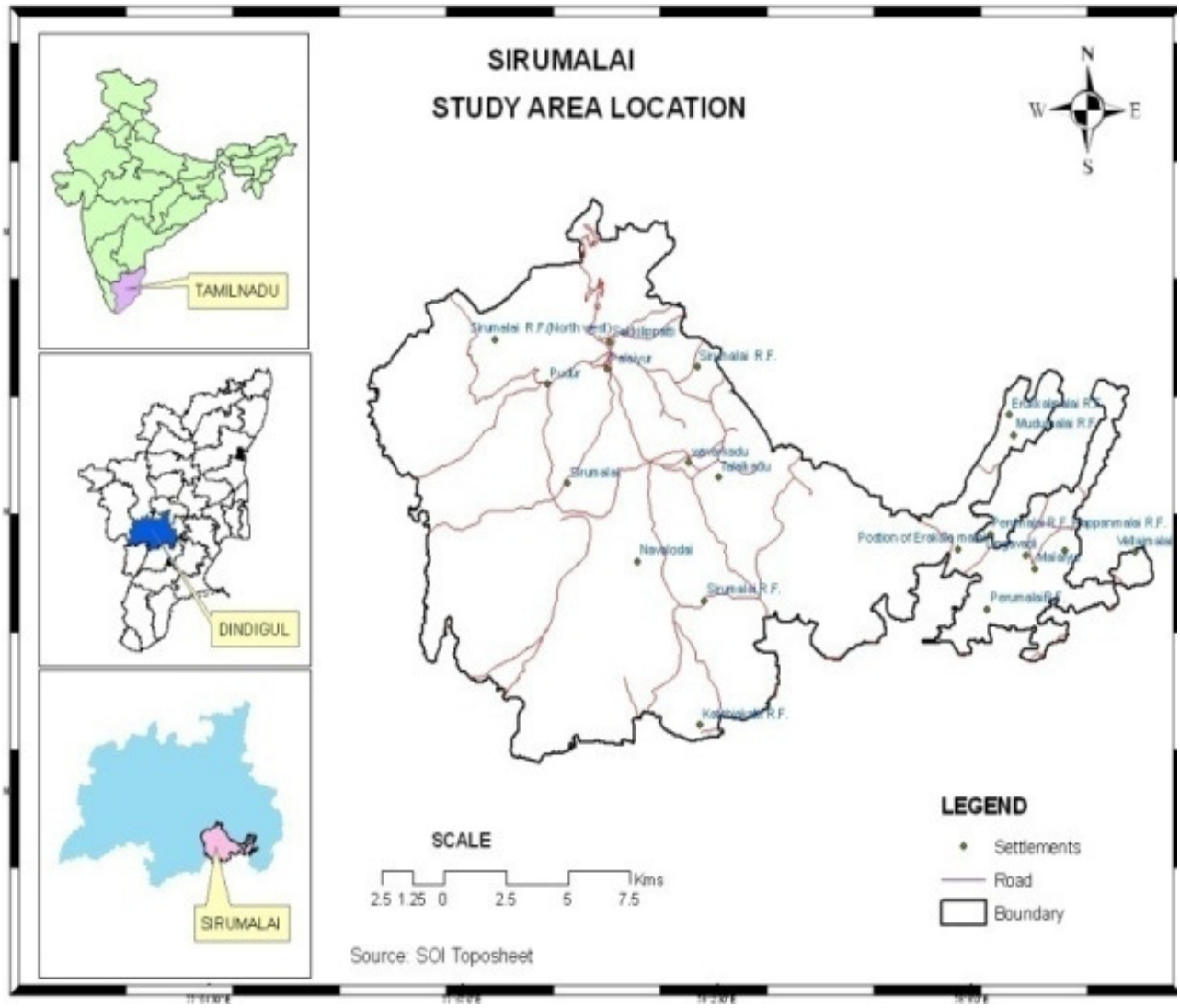


**Figure-1**
**Study area**

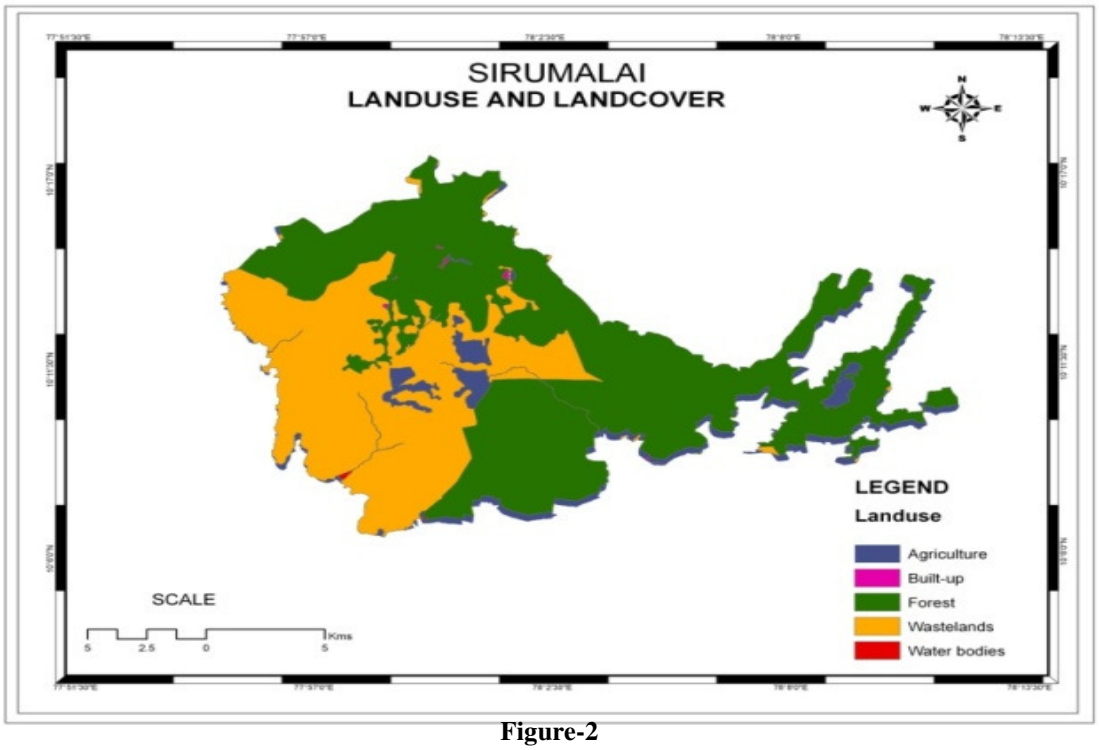


**Figure-2**
**Landuse / Landscover Map**

**Table-2**
**Landslide and Landuse pattern in SCLi**

| Landuse Category | Training Data-Set | | | Validation Data Set | |
|---|---|---|---|---|---|
| | LnadSlide Pixels | Landuse Pixels | SCLi | LnadSlide Pixels | SCLi |
| Agriculture | 35 | 23490 | -2.5133 | 1 | -0.64522 |
| wasteland | 2751 | 110961 | 0.29847 | 15 | 0.510226 |
| builtup | 0 | 326 | 0 | 0 | 0 |
| forest | 3107 | 184947 | -0.09073 | 10 | -0.40613 |
| waterboies | 0 | 638 | 0 | 0 | 0 |

**Sensitivity Co-efficient Analysis:** Sensitivity Co-efficient is most common quantification to evaluate landslide susceptibility to different landsuse patterns. Sensitivity Co-efficient Analysis is calculated as this formula:

$SCL_i = \ln [(L_i / A_i) / (L / A_T)]$

Where (SCLi) - Sensitivity co-efficient of Landslide susceptibility to different land use categories, $L_i$ - Number of landslide pixels in landuse categories. $A_i$ - area of each landuse type in the study area, $A_T$ – total area of atudy.

The $SCL_i$ analysis is used to study the landuse pattern impact of landslide susceptibility. The higher level values show that most important area for landslide susceptibility. Finally the validation set to verify the result of $SCL_i$ analysis.

The sensitivity co-efficient (table 2.) of the training set and validation set shows that the scrub forest and degraded forest is the most suitable categories (i.e) induces landslide susceptibility to grater extent, followed by the agriculture land and consisting the road construction .

Validation of the sensitivity co-efficient analysis is used by various land use categories and it's used temporal validation dataset consisting 26 landslides mapped in 2010. The sensitivity co-efficient calculated using the validation data-set mimics the analysis. Finally the observation also holds true on field investigation of the region to verify the results.

## Conclusion

Slope instability is the common problem in Hilly area. Land use pattern is one of the most important factors for landslide susceptibility. Each type of land use categories has a specific influence of slope stability of the region. The effect of each land

use pattern is studied in this paper using sensitivity co-efficient analysis. The result of the study scrap land, degrade land and road construction are most susceptible land use categories, followed by the agricultural land. The result of the analysis map fact that the area expanded the degraded forest and road construction. The irregular road construction is increasing the frequency of landslide along the drainage cutting areas. The study shows that land use planning and regulation are needed to save the hill down from slope instability related problem.

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