CHAPTER III
METHODOLOGY

This study applied the Geographic Information System (GIS) integrated with CA-Markov to classify land use pattern and predict land use change, then use Potential Surface Analysis (PSA) to analyze flood risk area and landslide risk area in Nakhon Si Thammarat Province.

3.1 Land use change study

This research uses Geographic Information System (GIS) to identify and track land use changed in 1994-2011. The scheme of studying land use changes in Nakhon Si Thammarat Province is shown in Figure 3-1.

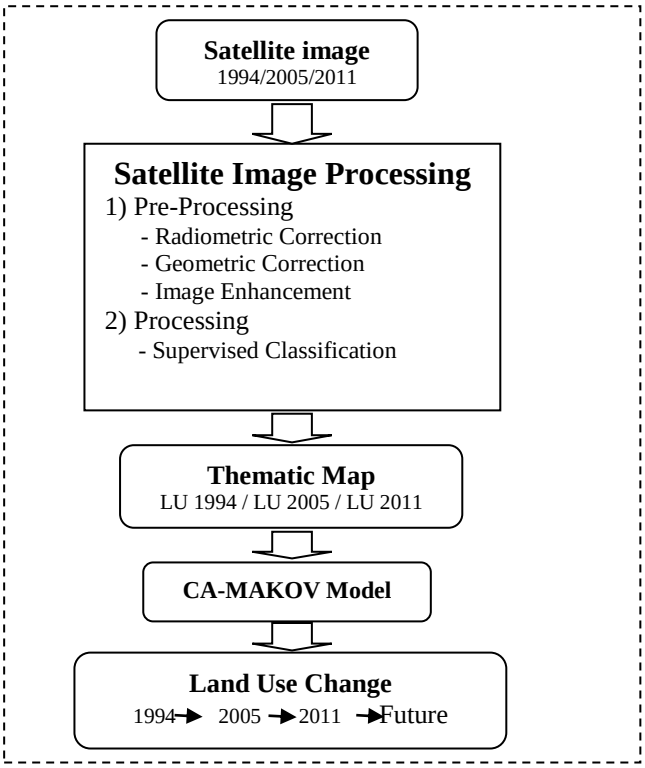

Figure 3-1 Scheme of studying land use changes in Nakhon Si Thammarat Province.
(Modified: Aingorn Chaiyes, 2008)

In this research, the classification of land use are based on common patterns found in the southern of Thailand, which including forest, para-rubber and orchard, agriculture, aquaculture and water-body, and built-up area.

The main data sources of this study were satellite images. Landsat-5TM images were used in 1994, 2005 and THEOS images were used in 2011. Table 3-1 and figure 3-2, 3-3, 3-4 shows the satellite image data.

Table 3-1 Satellite image data.

Time Series	Path/Row	Satellite	Source
1994	128/54, 128/55	Landsat-5 TM	GISTDA*
2005		Landsat-5 TM	GISTDA*
2011		THEOS	GISTDA*

*Geo-Informatics and Space Technology Development Agency

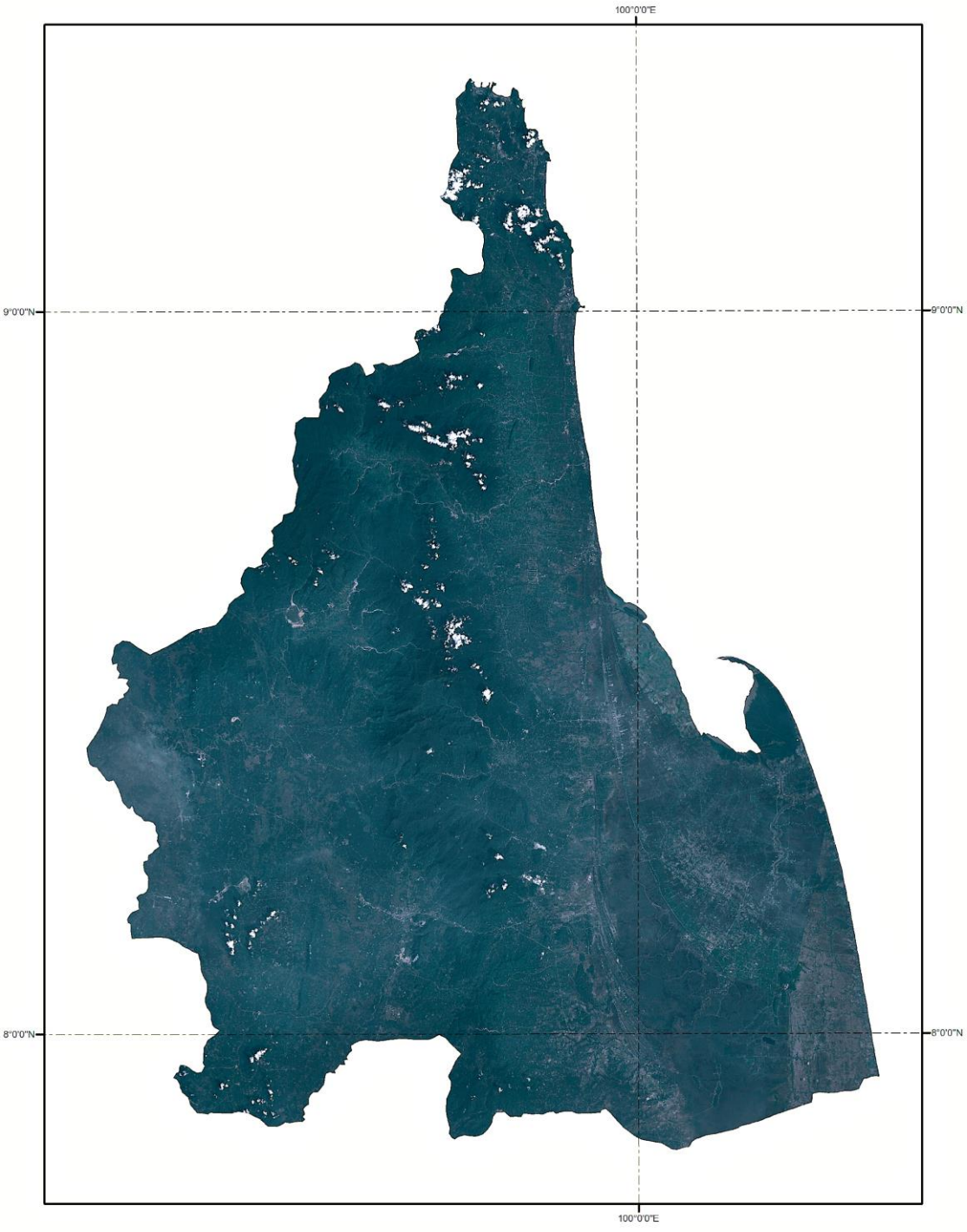

Figure 3-2 True color composite of Landsat 5TM (1994)

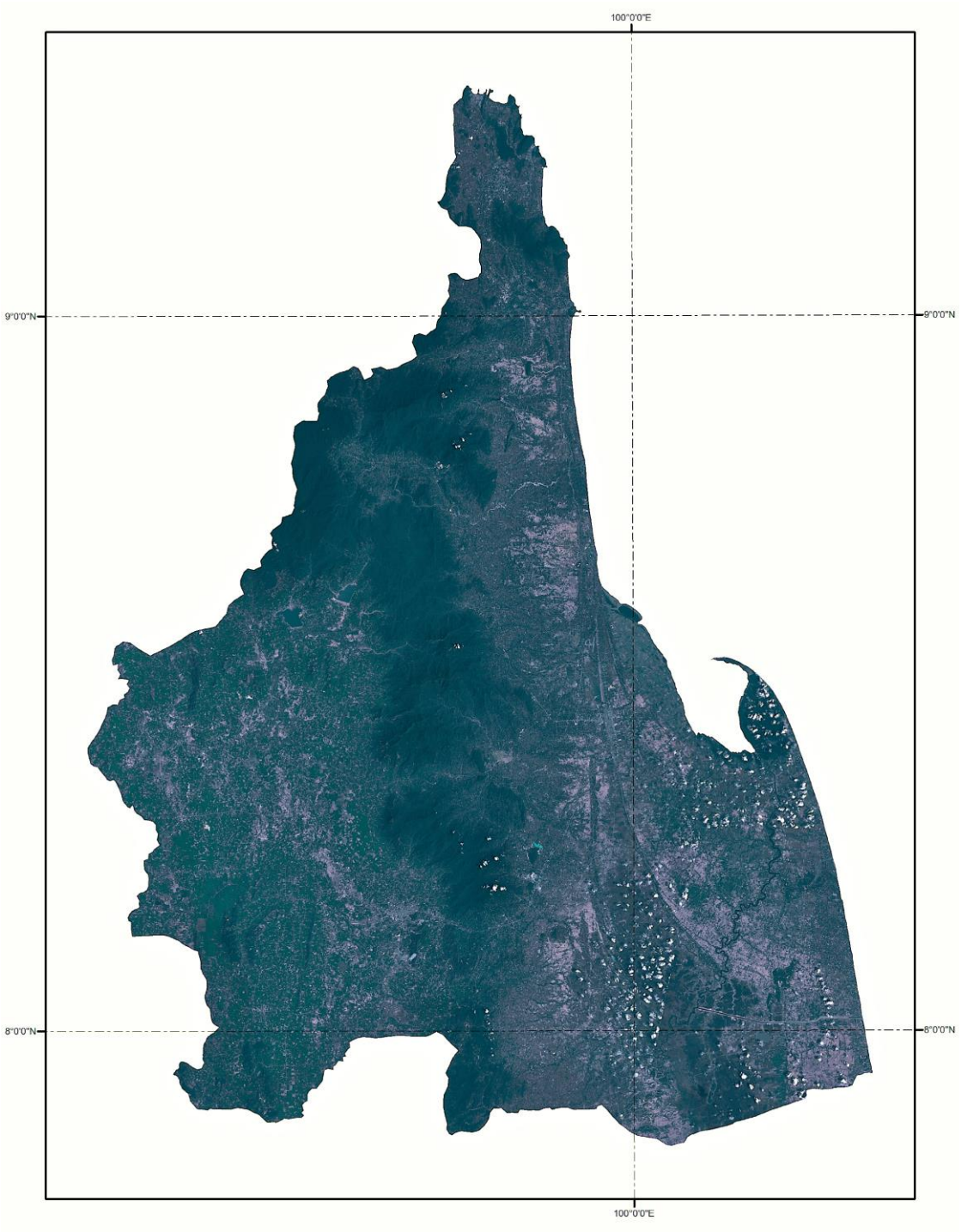

Figure 3-3 True color composite of Landsat 5TM (2005)

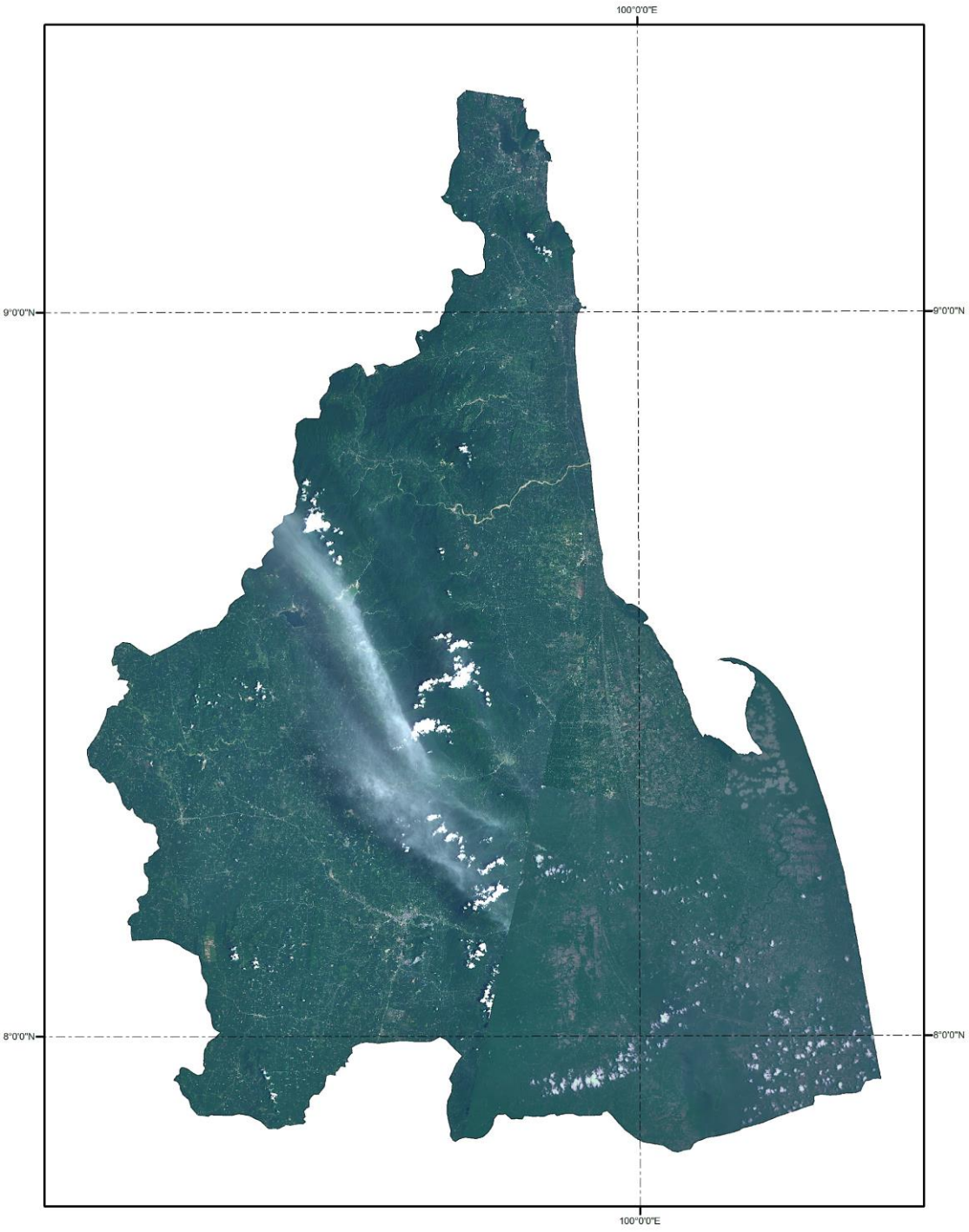

Figure 3-4 True color composite of THEOS (2011)

3.1.1 Satellite Image Processing

Supervised Classification The satellite image is the result of the detection of reflected ambient daylight (visible and near-visible spectra). The spectral response depends on nature of objects. The light is reflected off and this is used to create a characteristic signature for each habitat type. Each habitat signature will have its own values for each spectrum. Theses spectral values are used to create training site then applied to a whole image. For example, it determines areas where are a forest, orchards, buildings, etc. Then, it classifies all data by using Likelihood Classification to get the most accurate (12).

3.1.2 Land use prediction analysis This research using MARKOV theory to analyze land use trend in the future. This used land uses of 2005 and 2011 to analyze according to obtain the Transition probability, then, analyze by CA-MARKOV to obtain information of land use in the future.

3.2 Flood risk area mapping

This research uses Geographic Information System (GIS) and Potential surface analysis (PSA) to determine flood risk areas in the Nakhon Si Thammarat Province. The mapping methods are shown in figure 3.5

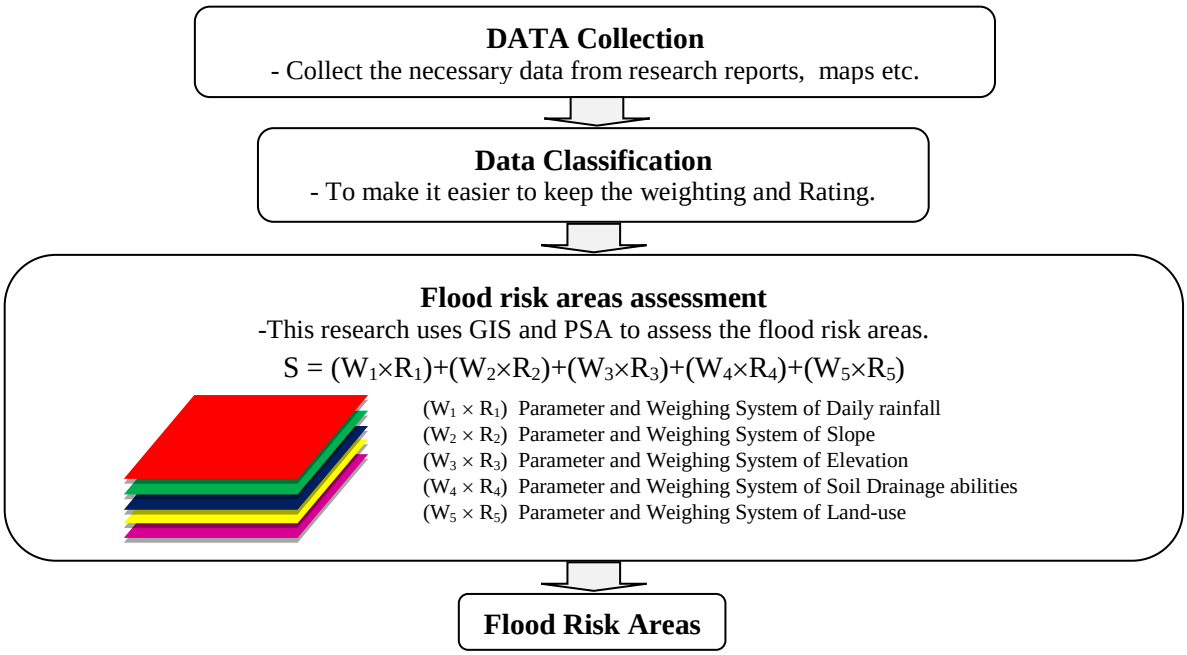

Figure 3-5 Schemes of flood risk areas mapping in Nakhon Si Thamarat Province.

3.2.1 Flood risk factor*s*

This study defines flooding factors by basing on related document, C. Yongchaleamchai(23) and P. Peudmongkol(24). It includes 5 factors which are rainfall, slope, elevation, soil textures and land use. Then information of flood risk data is shown in table 3.2.

Tables 3.2 Flood risk data

Flooding Factor	Year	Source
Daily rainfall	2012	Thai Meteorogical Department
Elevation		Royal Thai Survey Department
Slope		Royal Thai Survey Department
Soil drainage ability		Land Development Department
Land-use	2011	Satellite Image (GISTDA)

3.2.1.1 Daily Rainfall Rain fall directly relates with risk of flood and the areas with heavy rain have more flood risk. This study uses maximum rainfall per day value. It can be divided into 4 levels as follow. (23), (24)

1.) > 100 mm/ day

2.) 76 – 100 mm/ day

3.) 61 – 75 mm/ day

4.) 0 – 60 mm/ day

3.2.1.2 Slope Slope less areas have chance to get flood than very steep slope areas. Slope level can be divided into 4 types as follow. (23), (24)

1.) Slope 0 – 5 %

2.) Slope 6 – 10 %

3.) Slope 11 – 15 %

4.) Slope > 15 %

3.2.1.3 Elevation Low areas have chance to get flood more than high areas. Elevation can be divided into 4 types as follow. (23), (24)

1.) 0 – 100 m.

2.) 101 – 300 m.

3.) 301 – 500 m.

4.) > 500 m.

3.2.1.4 Soil drainage ability Soil texture refers to a size of clay particles. High clay particles are poor drainage than low clay particles. Drainage ability can be divided into 4 types as follow. (23), (24)

1.) Very Poorly drainage ability

2.) Poorly drainage ability

3.) Moderately well drainage ability

4.) Well drainage ability

3.2.1.5 Land Use and Land Cover Land use and land cover have affect to flooding. That is the area covered by perennial plant has flooding affect less than non-covered because the perennial plants can absorb water and slow-down the water flow. Land use and land cover can be divided into 4 types as follow. (23), (24)

1.) Built-up area.

2.) Agriculture, aquaculture area

3.) Perennial plant (orchard, para rubber, etc.

4.) Forest

3.2.2 Weighting and Rating Technique

High influence factors will get higher value than least influence factors. Details of weighting and rating technique are shown in table 3.3. (25), (26)

Table 3.3 Flood risk parameter of weighting and rating technique.

Factor	Weighting	Data types	Rating
1. Daily rainfall	6	>100 mm. 76-100 mm. 61-75 mm. 0-60 mm.	4 3 2 1
2. Slope	4	0-5% 6-10% 11-15% >15%	4 3 2 1
3. Elevation	3	0 – 100 M. 101 – 300 M. 305 – 500 M. > 500 M.	4 3 2 1
4. Soil drainage abilities	2	- Very poorly drainage ability - Poorly drainage ability - Moderately well drainage ability - Well drainage ability	4 3 2 1

Factor	Weighting	Data types	Rating
5. Land-use	1	- Built-up land - Agriculture, aquacultural area - Perennial plant (orchard, para rubber, etc.) - Forest	4 3 2 1

Note : Weighting Score divided into 4 levels as follow.

- High risk 4
- Moderate risk 3
- Low risk 2
- No risk 1

3.3 Landslide area mapping

This research uses Geographic Information System (GIS) and Potential Surface Analysis (PSA) to determine landslide hazard areas in the Nakhon Si Thammarat Province. The mapping methods are shown in figure 3.6

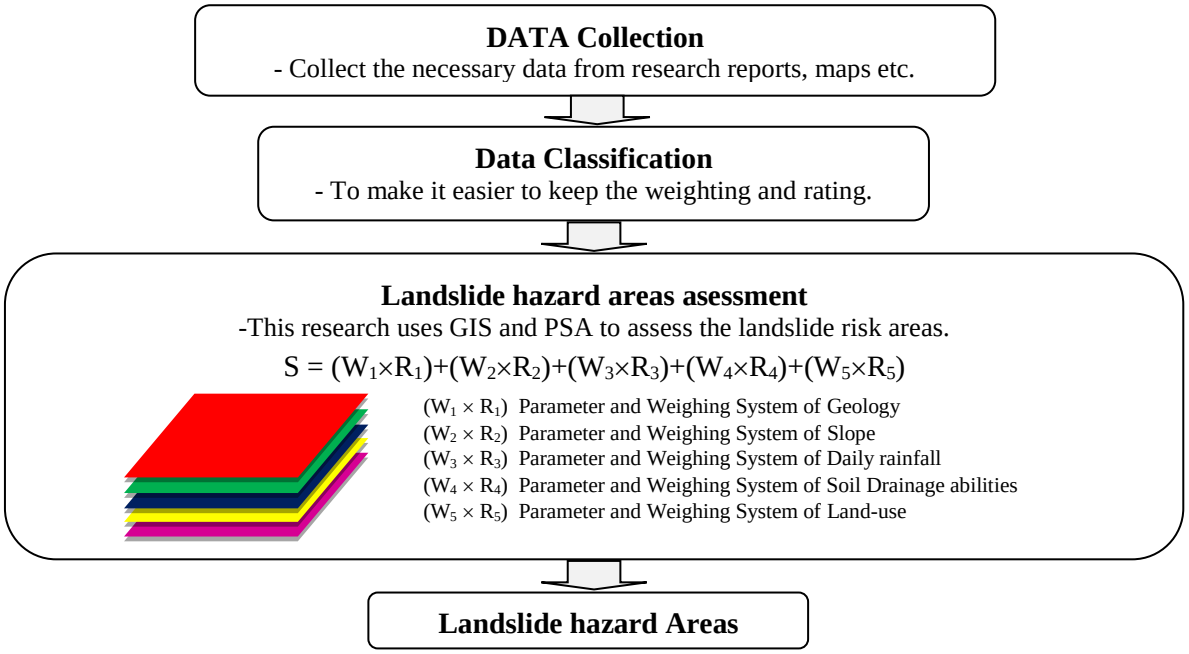

Figure 3-6 Scheme of landslide hazard mapping in Nakhon Si Thamarat Province.

3.3.1 Landslide risk factors

This study defines landslide factors by basing on related document, Esser Gabrielle (27). It includes 5 factors which are geology, slope, rainfall, soil textures and land use. Information of flood risk data is shown in table 3.4.

Tables 3.4 Landslide risk data

Flooding Factors	Source
Geology	Department of Mineral Resources
Slope	Royal Thai Survey Department
Daily rainfall (year 2012)	Thai Meteorogical Department
Soil drainage ability	Land Development Department
Land-use	Satellite Image (GISDA)

3.3.1.1 Geology can be divided into 4 types as follow. (27)

1.) Granite

2.) Shale, limestone

3.) Sandstone

4.) Sedimentary rock

3.3.1.2 Slope Very steep slope areas have chance to landslide than Slope less areas. Slope level can be divided into 4 types as follow. (27)

1.) Slope > 60 %

2.) Slope 41 – 60 %

3.) Slope 21 – 40 %

4.) Slope 0 – 20 %

3.3.1.3 Daily Rainfall Rain fall directly relates with landslide, areas with heavy rain have more risk. This study uses maximum daily rainfall. It can be divided into 4 levels as follow. (27)

1.) > 100 mm/ day

2.) 76 – 100 mm/ day

3.) 61 – 75 mm/ day

4.) 0 – 60 mm/ day

3.3.1.4 Soil drainage abilities Soil texture refers to a size of clay particles, high clay particles are poor drainage ability than low clay particles. Drainage ability can be divided into 4 types as follow. (27)

1.) Very poorly drainage ability

2.) Poorly drainage ability

3.) Moderately well drainage ability

4.) Well drainage ability

3.3.1.5 Land Use and Land Cover Land use and land cover have affects to landslide. That is the areas covered by perennial plants have landslide effect less than non-covered because the perennial plants can absorb water. Land use and land cover can be divided into 4 types as follow. (27)

1. Built-up area

2. Agriculture, aquaculture area

3. Perennial plant (orchard, para rubber, etc.)

4. Forest

3.3.2 Weighting and Rating Technique

High influence factors will get higher value than least influence factors. The details of weighting and rating technique are shown in table 3.5

Table 3.5 Landslide parameter of weighting and rating technique.

Factors	Weighting	Data types	Rating
1. Geology	5	- Granite - Shale, limestone - Sandstone - Sedimentary rock	4 3 2 1
2. Slope	4	- Slope > 60 % - Slope 41 – 60 % - Slope 21 – 40 % - Slope 0 – 20 %	4 3 2 1
3. Daily rainfall	3	>100 mm. 76-100 mm. 61-75 mm. 0-60 mm.	4 3 2 1
4. Soil drainage abilities	2	- Very bad drainage ability - Bad drainage ability - Moderate drainage ability - Good drainage ability	4 3 2 1
5. Land-use	1	- Built-up land - Agriculture, aquacultural area - Perennial plant (orchard, para rubber, etc.) - Forest	4 3 2 1

(Modified : Ruthairat mangsilp, 2006)

Note : Weighting score is divided into 4 levels as follow.

- High risk 4
- Moderate risk 3
- Low risk 2
- No risk 1