Chapter 3

RESEARCH METHOD

3.1 Study area

3.1.1 Geographical location and administrative setting

Dinhquan district with total area of 96,650 ha, locates about 85 km from Bienhoa city of Dongnai province and 115km from Hochiminh city in the west direction. It is divided into 13 communes and 1 town. Distribution of land in Dinhquan administrative boundary was presented in Table 3.1. The highway is running west-north and east-south, connecting Bienhoa city and Dalat city the two best administrative and commercial centers of east-south area and Lamdong highland (Department of Agricuture and Rural Development of Vietnam, 1998). Besides, Dinhquan has 17,501ha of TriAn pond that belongs to watershed of Dongnai and Langa rivers; it serves as a major water source to supply Trian hydroelectric plant, other production and living activities (Trian Hydroelectric Plant, 1995). The administrative boundary map indicates the geographical location of study area (Figure 3.1).

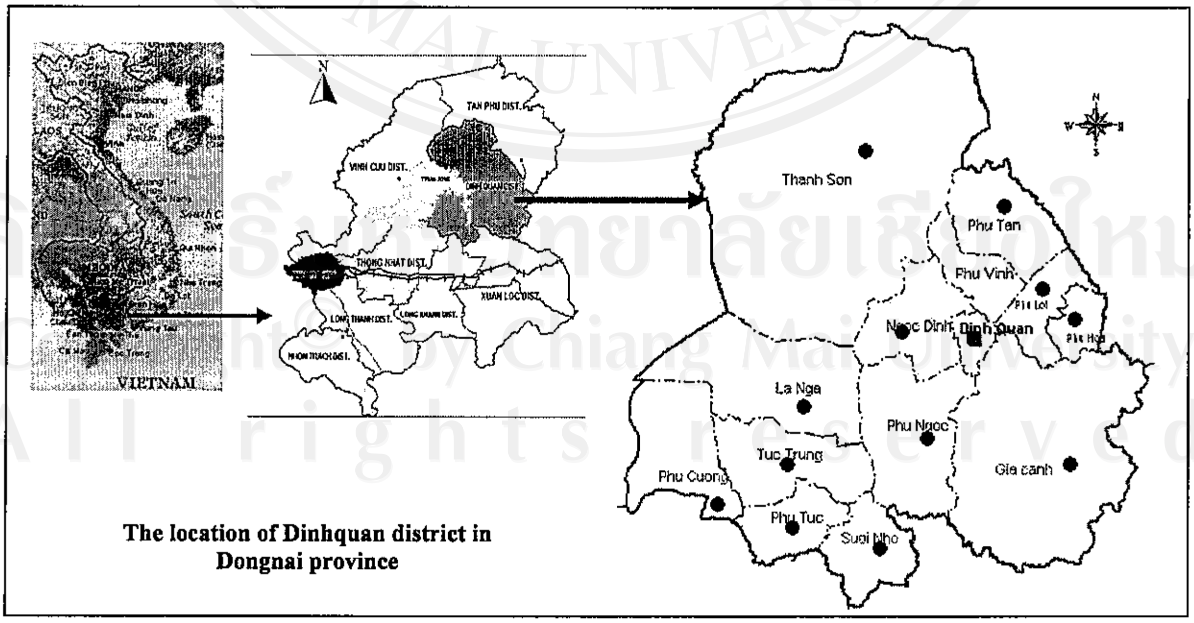

Figure 3.1 The location of Dinhquan district

Table 3.1 Distribution of land in administrative boundary

	Name of communes	Area (ha)	Proportion (%)
1	Dinhquan town	765	0.8
2	Phucuong	5,458	5.6
3	Phutuc	2797	2.9
4	Tuctrung	4,965	5.1
5	Suoinho	3,231	3.3
6	Ngocdinh	4,514	4.7
7	Phuloi	2,548	2.6
8	Phuvinh	2431	2.5
9	Phutan	4,408	4.6
10	Giacanh	17,233	17.8
11	Phungoc	6,773	7.0
12	Langa	8600	8.9
13	Thanhson	31,345	32.4
14	Phuhoa	1,582	1.6
Total area		**96,650**	**100**

(Source: People Committee of Dinhquan, 2000)

3.1.2 Topographic condition

Dinhquan is a transition area between highland and midland. Its topography is rolling, gently sloping hills with the average gradient of about 2.5% in the northeast and southwest direction. The average elevation is 180 m above mean sea level (amsl). The landscape of Dinhquan was shown in Figure 3.2.

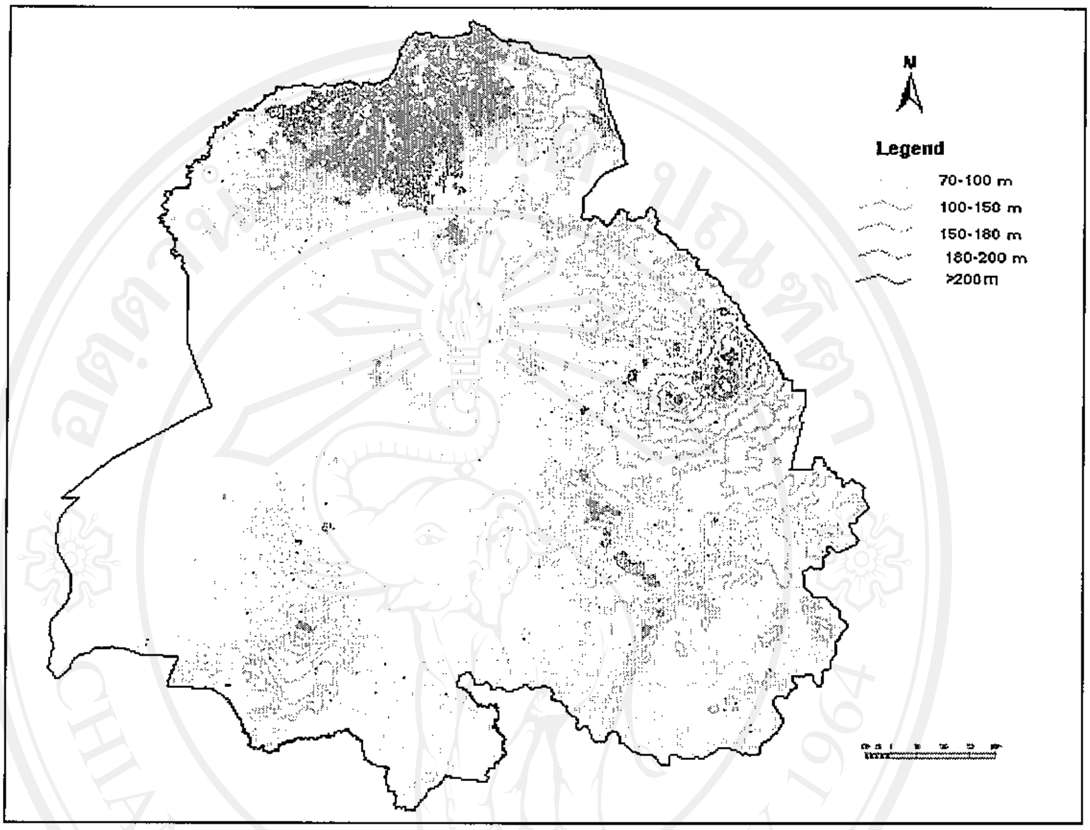

Figure 3.2 Slope map of Dinhquan district

3.1.3 Hydro meteorological condition

Climate

Climate of Dinhquan district is tropical monsoon subequatorial, temperature is relatively stable all year round (Table 3.2). There are 2 distinct seasons; the rainy season is from May to November causing condition in east-south region of Vietnam being hot and humid in the rainy season. Besides, it also affects climate of the highland (Baoloc-Lamdong) causing very high rainfall during the rainy season. This is the main cause leading to flooding in Trian pond. The dry season starts from September to April with east-north monsoon and characterized by relative hot and dry, and high humidity.

Table 3.2 The climate of Dinhquan district

Climate parameters	Unit	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	^0C												
Average	^0C	25.9	26.3	27.6	28.3	27.8	26.9	26.4	26.4	26.2	26.2	26.2	25.4
Max	^0C	36.2	36.7	39.1	38.1	39.6	34.7	34.6	34	34.2	33.4	34.2	33.4
Min	^0C	15.6	18.5	17.5	21.3	21.4	21.6	21	21.6	22.1	20.4	20.7	16.2
Rainfall	mm	11	9	27	88	210	297	285	374	377	257	105	43
Average Humidity	%	73	71	69	74	80	87	88	89	88	96	81	78
Evaporation	mm	166	183	226	17.9	127	89	82	83	70	81	99	119
Sunny time	H	263	252	277	246	220	203	182	177	151	205	213	198

Source: Hydro Meteorological Center of Dongnai Province, 2000

Hydrographical condition

Water surface

Two main rivers, Langa and Dongnai serve as main water sources to supply water for production and livings in some provinces in the eastern region of the South Vietnam. However, water level changes following seasons with very wide amplitude, in dry season there is almost no water but in rainy season, there are some flooded areas causing damages to agricultural production.

In the transition area between midland and highland of Dinhquan many watersheds and drainage networks form rivers and streams with many whirlpools and waterfalls.

Underground water

The depth of exploiting wells is from 6-30 meter; underground water is being exploited with small and medium scale for agricultural production in dry season and household consumption.

3.1.4 Natural resource: land and mineral resource

Soil types

Soil map of Dinhquan district with the scale of 1/25,000 had been published following the classification method of Ministry of Agriculture of Vietnam in 1976. The soil map of Dongnai province has the scale of 1/50,000, FAO/UNESCO classification method was used and completed in 1996.

Total investigated area is 78,784 ha (not concluding 17,866 ha of TriAn pond and security area), soil types in Dinhquan district are divided into 3 hierarchical classes: soil group, soil unit and soil subunit.

There are 5 main soil groups: Acrisols, Andosols, Ferrasols, Luvisols and Gleysols. Each group is divided into several units and subunits (Figure 3.3 and Table 3.3).

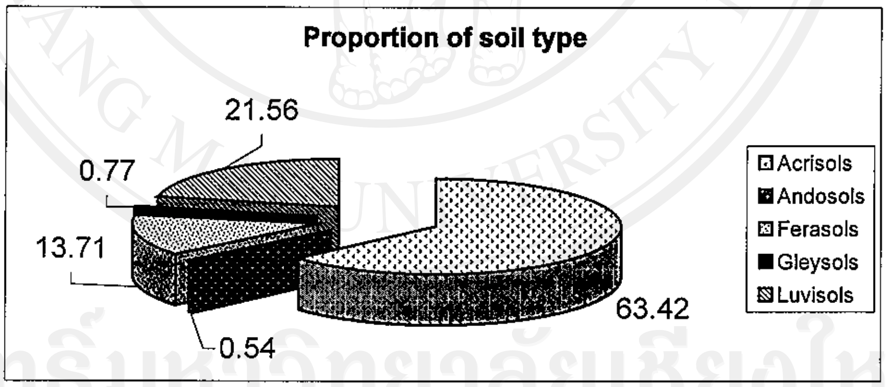

Figure 3.3 Proportion of main soil types in Dinhquan

Table 3.3 Soil types in Dinhquan

Notation	Soil name		Area
	FAO/UNESCO	**Vietnam**	**(ha)**
AC	**I. Acrisols**	**Grey soil**	**49,962**
ACf	***1.Ferric Acrisols***	***Clotted grey soil***	
ACf.fh1/SCII	-Epihyperferric Acrisols	Clotted grey soil with shallow layer	
ACf.fh2/SCII	-Endohyperferric Acrisols	Clotted grey soil with deep layer	
ACg	***2. Gley Acrisols***	***Gleyic grey soil***	
ACg.feI/GRII	-Epiferri Acrisols	Clotted Gleyic grey soil with shallow layer	
ACg.vr/GRII	-Verti Acrisols	Chapped grey soil	
ACr	***3.Arenic Acrisols***	***Grey soil with Light mechanical composition***	
ACr.LiI/SCV5	-Epilithi Arenic Acrisols	Mixed stone grey soil with Light mechanical composition in shallow layer	
ACr.ve/GRII	-Epilithi Chromic Acrisols	Grey soil with light mechanical composition, poor base	
ACx	***4.Chromic Acrisols***	***Yellow chrome grey soil***	***40,108***
ACx.fa/SCII	-Hyperferralic Chromic Acrisols	Yellow chrome grey soil that agglomerated Fe & Al	
ACx.LiI/SCIII	-Epilithi Chromic Acrisols	Yellow chrome grey soil with shallow rock layer	
Acx.Li2/SCI2	-Endolithi Chromic Acrisols	Yellow chrome grey soil with deep rock layer	
AN	**II.Andosols**	**Pumice stone soil**	**427**
ANh	***1.Haplic Andosols***	***Typical Pumice stone soil***	
ANh.LiI	-Epilithi haplic Andosols	*Typical* Pumice stone soil with shallow rock layer	
FR	**III.Ferrasols**	**Red soil**	**10,799**
FRr	***1.Rhodic Ferrasols***	***Dark red soil***	
FRr.fe1/BTIII	- Epiferri Rhodic Ferrasols	Dark red soil that clotted and shallow rock layer	
FRr.ac/BTII	- Acri Rhodic Ferrasols	Dark red soil that agglomerated clay	
FRr.fe/BTIII	- Epiferri Rhodic Ferrasols	Dark red soil that clotted a little	
FRr.fh1/BTII4	-Epihyperferri Rhodic Ferrasols	Dark red soil that clotted much in shallow layer	
FRr.fh2/BTII4	-Endohyperferri Rhodic Ferrasols	Dark red soil that clotted much in deep layer	
FRx	***2. Xanthic Ferrasols***	***Yellow red soil***	***2846.40***
FRx.ac/BTIV4	-Acri Xanthic Ferrasols	Yellow red soil agglomerated clay	386.91
FRx.fh1/BTIV4	-Endohyperferri Xanthic Ferrasols	Yellow red soil that clotted much in shallow layer	2459.48
GL	**IV.Gleysols**	**Gley soil**	**608.86**
GLu	***1.Umbric Gleysols***	***Humus gley soil***	***608.86***
GLu.eu/AIII	-Eutri Umbric Gleysols	Humus gley soil and little acid	608.86

Notation	Soil name		Area
	FAO/UNESCO	Vietnam	(ha)
LV	**V. Luvisols**	**Black soil**	**6986.51**
LVf	***1.Ferric Luvisols***	***Clotted black soil***	***2925.13***
LVf.feI/BTII4	- Epiferric Luvisols	Little clotted black soil in shallow layer	51.30
LVf.fh1/BTII4	- Epihyperferric Luvisols	Much clotted black soil in shallow layer	1612.62
LVf.fh2/BTII4	- Endohyperferric Luvisols	Much clotted black soil in deep layer	1261.21
LVg	***2. Gleyic Luvisols***	***Gley black soil***	***2897.55***
LVg.fe2/BTI5	-Endoferric Gleyic Luvisols	Little clotted gley black soil in deep layer	82.94
LVg.Li1/BTII4	Epilithi Gleyic Luvisols	Stony gley black soil in shallow layer	174.18
LVg.vefhI/BTI4	Epihyperferric Verti Gleyic Luvisols	Poor base gley black soil that clotted little in shallow layer	157.09
LVg.vrfe1/BTII	Epiferri verti Gleyic Luvisols	gley black soil that clotted little in shallow layer	1123.94
LVg.vrfh1/BTI3	Epihyperferferri Verti Gleyic Luvisols	gley black soil that clotted much in shallow layer	978
LVg.vrli1/BTI5	Epilithi Verti Gleyic Luvisols	Chapped stony gley black soil in shallow layer	30.22
LVg.vrli2/BTII	Endolithi Verti Gleyic Luvisols	Chapped stony gley black soil in deep layer	351.17
LVh	***3. Haplic Luvisols***	***Typical black soil***	***238.50***
LVh.li1/BTII5	-Epilithi Haplic Luvisols	Typical black soil in shallow rock layer	238.50
LVx	***4. Chromic Luvisols***	***Dark brown black soil***	***10925.34***
LVx.fe1/BTI4	-Epiferri Chromic Luvisols	Dark brown black soil that clotted little in shallow layer	111.39
LVx.li1/BTI4	-Epilithi Chromic Luvisols	Dark brown black soil in shallow layer	10813.95
Total investigated area			78,784
Total uninvestigated area			17,866
Total area			**96,650**

Source: Soil Classification of Dinhquan district, 2002

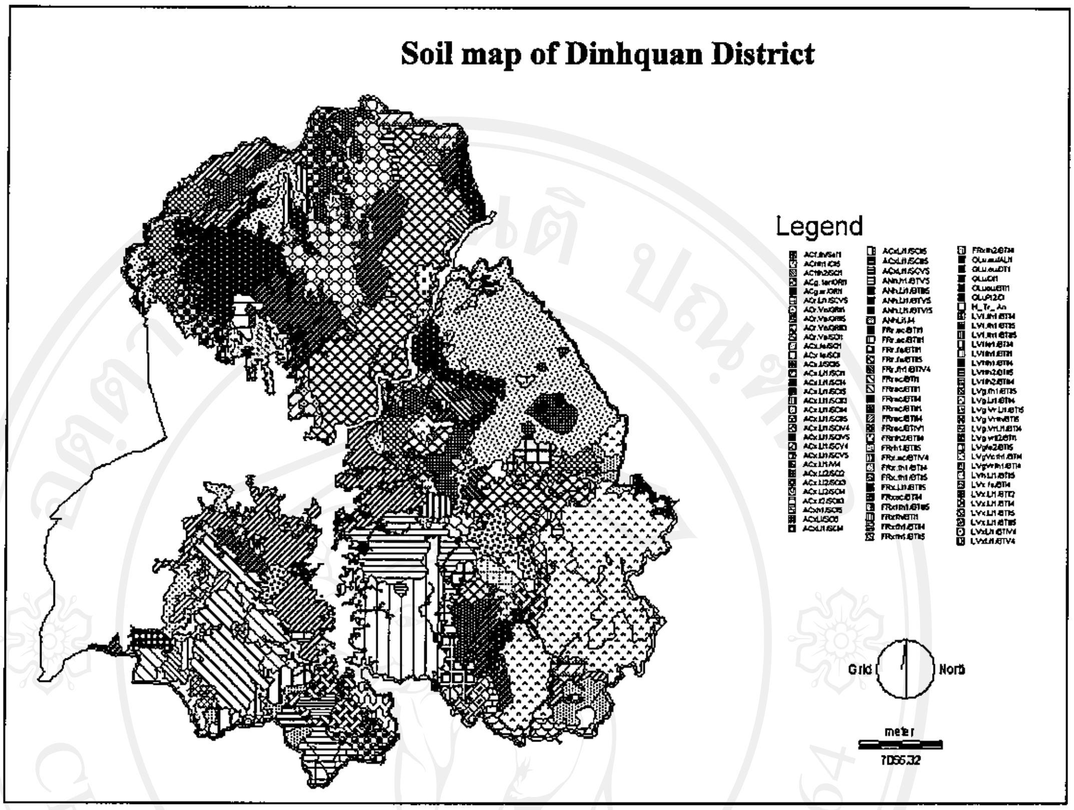

Figure 3.4 The soil map of Dinhquan district

Mineral resources

In Dinhquan, minerals are not diverse, there are only rock mines that located in Giacanh commune. Potential of this resource is at fair level comparing with other areas. Thus, appropriate methods of investment and exploit are interested so that unused area of district is used effectively. Besides, in VinhAn hamlet, Langa commune, there is an area of kaolin, the material that is used for ceramic and building industry.

3.2 Existing land use types

Agricultural land occupies about 39.7% (38,407 ha) (Table 3.4). This is the result of land improvement and the occupation of the unused land and inefficient forestland. Forestland is still high proportion (36.9%) and this area is very important to ecological environment of the region, particularly the protective forest areas around Trian pond. The special purpose land occupied 20.19%, it has an important role in developing socio-economic infrastructures and cultural community. This area is increasingly expanded and improved. Other land use types are residential land (1.2% or 1,199ha) and unused land (1.9% or 1,866ha). The distribution of each land use type is shown in Table 3.4 and Figure 3.5.

Table 3.4 Structure of land use types of Dinhquan in 2003

Land use types	Area (ha)	Proportion (%)
Agricultural land	38,407	39.74
Forest land	35,660	36.90
Special purpose land	19,518	20.19
Residential area	1,199	1.24
Unused land	1,866	1.93
Total	**96,650**	**100**

Source: People Committee of Dinhquan district, 2003

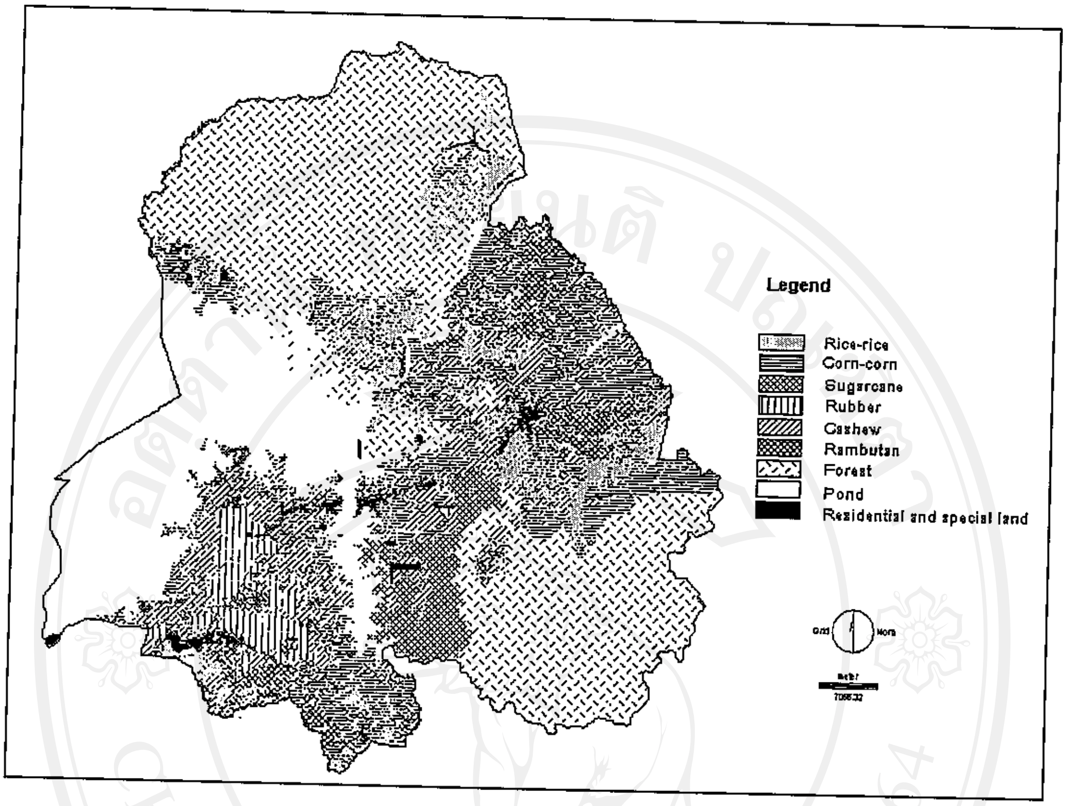

Figure 3.5 Land use map of Dinhquan district in 2003

3.3 Frame work of the study

The main procedure used for land evaluation is presented in Figure 3.6. There are two main parts in this framework. The first part is land mapping unit (LMU) delineation, GIS was used to delineate LMU following IPDA criteria (IPDA, 1995).

The second part is land evaluation procedure, the process started with the identification of relevant land utilization types. Land use requirements were defined from FAO and IPDA framework (FAO 1983, IPDA 1995) for particular LUT. Land quality (LQ) for determining land use requirement (LUR) were selected with criteria of obtainability, effectiveness on land use and occurrence of critical value to assess suitability level. These selected LQ could be obtained from land characteristics of each LMU. Idrisi 32, a raster GIS software (Eastman, 2001) with a multi-criteria decision-making module was used to generate suitability indexes and maps for particular land utilization type.

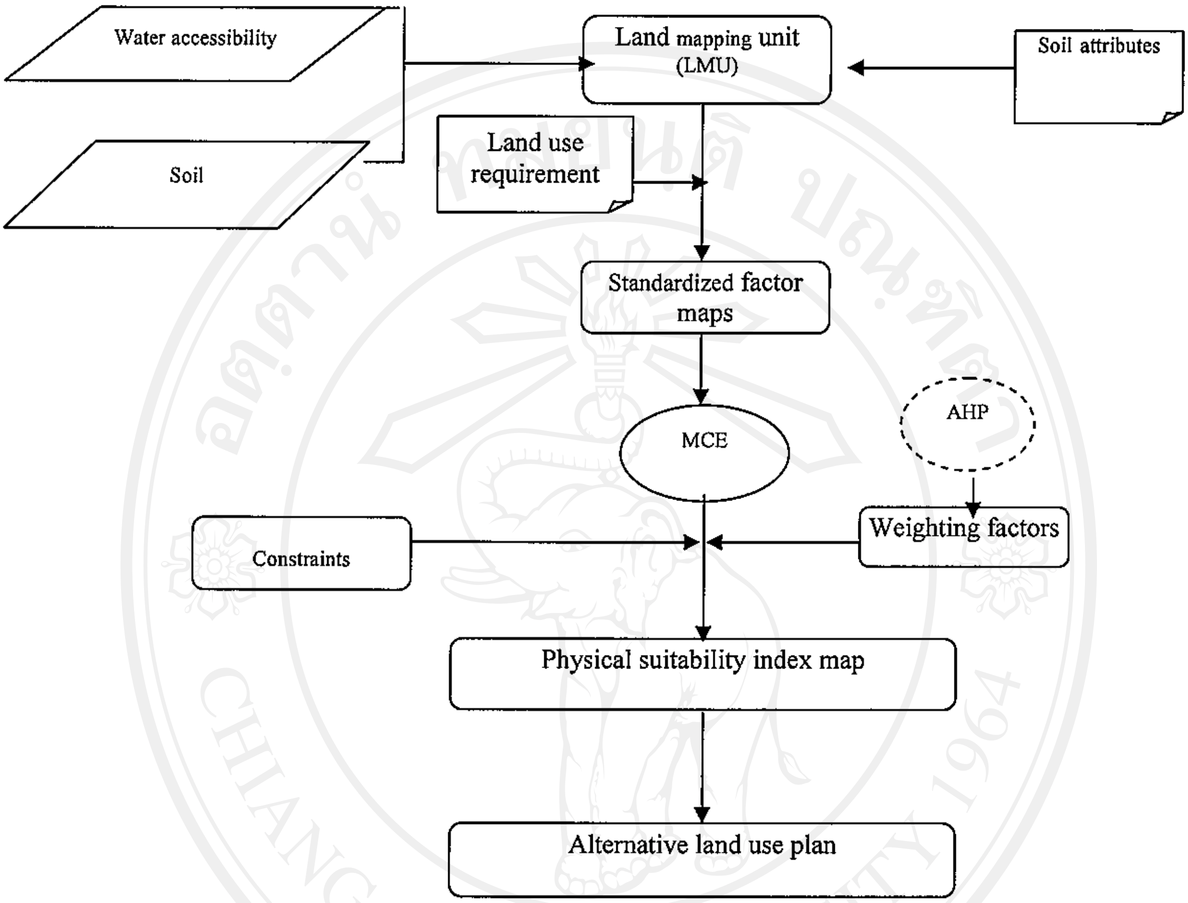

Figure 3.6 The framework for land evaluation used in the study

3.4 Data collection

The dataset required for land evaluation includes maps of land use, soil types, and elevation, hydrographic and socio-economic data. Soil map is at the scale of 1:25,000 classified by the method of Ministry of Agriculture and Rural Development of Vietnam in 1976. The soil map of Dongnai province with the scale of 1:50,000 classified according to method of FAO/UNESCO in 1996. It was carried out to correct and supplement the soil map of Dinhquan the Center of Technological Cadastral, obtained from the provincial office of the Department of Cadastral and Housing Land Service (CHLS) of Dongnai. The topographic map was obtained from existing database of CHLS of Dongnai province since 1999; its scale is 1:25,000. Hydrographic data was obtained from Xuanloc weather observation station. The land cover map was compiled from cadastral maps of communes with the scale of 1:1000, 1:2000 and 1:5000.

LMU was based soil map that had been produced with the scale of 1: 25,000 by Department of Land Administration of Dongnai province in the collaboration with the University of Agriculture and Forestry of Ho Chi Minh city.

The related social and economic data were collected from Statistic Office of Dinhquan, annual reports of communes and the People's Committee of Dinhquan district. Data used for assessing economic of the land were obtained from a formal survey of 140 farmer households in 14 communes of Dinhquan. Besides, key imformants, agricultural extension officer and researchers are also interviewed to obtain information of LUT and agricultural production. The score weight of each factor for particular LUT was involved in this interview. Land use requirement for each LUT was obtained from guidelines and tables published by IPDA (1995), Ministry of Agriculture and Rural Development (1991), and FAO (1985).

3.5 Data transformation

Most of data are from many data sources in various data formats, soil maps and land use map are in the formats of Microstation (*.dgn) and MapInfo software (*.tab). Firstly, data were converted into files in Mapinfo to create LMU map. Then, they were changed into *.rst and *.vct files of Idrisi format. Topography in Microstation format (*.dgn) was converted into *.tab file in MapInfo and then changed into *.rst and *.vct file in Idrisi to carry out multicriteria procedure evaluation. All of factor maps are in Idrisi format and consist of rainfall, slope, soil drainage, depth, OM, pH, stoniness and rock out crop maps. A constraint map consists of roads, water bodies, planning constructions of local government, forest area and villages were also converted from *.tab file and extracted from the land use map.

3.6 Land Mapping Unit (LMU)

LMUs had been constructed from the soil map with the scale of 1:25,000. It was considered as a base map for land evaluation. The collected documents (hydrographic, agricultural climate, topography, flooding, ect.) and results of household interview were used for obtaining some attributes data in soil units for LMU. Each soil type expressed differences of soil depth, soil drainage, slope, stoniness on the surface, rainfall, pH and OM. Mapinfo was used for inputting LMU map into digital formats and stored as vector files. Each LMU is the result of the overlay of characteristics of soil types.

3.7 Identification of Land Utilization type (LUT)

The main LUTs selected for land in this study were based on the common and potential land use types in the area. They are double crops of paddy rice in irrigated areas, double crops of corn in rainfed area, sugar cane, rubber, cashew and rambutan in rainfed areas.

The description of each LUT includes varieties and growing period. This information was collected from published reports and informal interview.

In Dinhquan, irrigated rice is still considered as the most important food crop for local demand of people. Food security is an important strategy, farmers and local government must maintain rice areas although its economic benefit is less than some other crops. Most of areas with good water sources are used to grow rice. Paddy rice cultivation is popular and regarded as one form of permanent agriculture. Here, paddy rice is usually cultivated double crop while area of mono paddy rice crop has low annual productivity. In this study, summer paddy rice crop and main paddy rice crop was selected for evaluation.

Rainfed corn is the second most important food crop in this area. Corn is attractive to farmer because of its marketable value. Farmers can use land that has a few stones on the surface or high slope (0-10^0) to cultivate double crops of corn in a year. Summer corn crop and winter corn crop is the cropping system that is selected for land evaluation.

Sugarcane is a cash crop, focused on some communes (Phungoc, Langa) aiming to supply raw material for Langa Sugar factory. Farmers who produced sugar canes received credits from the factory and settled it after harvesting.

Rubber tree is industrial crop, the majority of rubber plantation belong to state companies. Only small rubber area belongs to private farms, known as "small scale rubber farm" (rubber of "tieu dien"). For farmers who are workers in rubber companies and their families have large cultivated area, rubber can be a cash crop because the product can be sold to rubber companies.

Cashew is a crop of the 327 Program of the government commonly known as "Makes Bare Land Green" and the program called "One Crop, One Livestock" for developing economic of each commune. This crop is cultivated on poor land quality. Cashew (Indian variety) is the raw material for Dongnai Cashew process factory, which focused on Ngocdinh, Phucuong, Tuctrung, Phutuc communes in Dinhquan.

Rambutan is a popular crop grown in orchards in the study area. Previously, farmers had cultivated coffee but the cost for accessing water source was high and the price of coffee dropped since 1997. The farmers cut down coffee and replaced by fruit tree to gain stable income. Rambutan intercropped with durian is the system that generates high benefit.

3.8 Land Use Requirement (LUR)

There are 25 land qualities (LQ) used in the guideline of land evaluation for rainfed agriculture (FAO, 1983). This guideline had been tested in Indonesia and reported as the table of land characteristics grouped by land quality rating for each land suitability ratings (CSR/FAO, 1983). Soil scientists in Vietnam also adopted this framework that was tested and modified for the agro-ecosystems of Vietnam. They combined with some indices for land classification in agricultural tax and called it as the "qualitative land evaluation manual" (IPDA, 1995).

LUR of particular LUT in the study area was defined from the table of qualitative application of FAO framework for land evaluation (Dalal and Dent, 2001) for irrigated paddy rice and tables of IPDA (1995) for rainfed corn, sugarcane, rubber and cashew. LUR of fruit tree was defined using LUR of the perennial crop in Land Classification for Agricultural Tax of Ministry of Agriculture and Rural Development (1991). LUR for fruit tree in "Soils for Fruit Trees" at the web site http://pearl.agcomm.okstate.edu/hort/fruits/f6216.htm (Stiegler, 2001) with some modification according to the experts' and local officers' knowledge. Criteria selected for land use requirement are soil drainage, water condition (rainfall for rainfed LUT or water accessibility for irrigated LUTs), soil depth, surface stoniness, slope, organic matter (OM) and pH. The LUR for major crops in Dinhquan was summarized from Table 3.5 to Table 3.10.

Table 3.5 LUR for irrigated summer rice crop and main rice crop

Land qualities	Diagnostic land characteristics	S1	S2	S3	N
Sufficiency of water	-Water accessibility	Good	Good	Good	Poor
	-Soil drainage class	Poorly drained	Poorly drained	Moderately drained	Well drained
	-Soil depth (cm)	>80	60-80	40-60	<40
Sufficiency of nutrients	-pH	6-7	5-6 7-8	4.5-5 8-8.5	<4.5 <8.5
	-OM	>2.5	2-2.5	1.5-2	<1.5
Ease of water control	Slope (degree)	0-3	3-5	5-8	>8
Ease of cultivation	Stone and rock outcrop (%)	0	1-5	5-10	>10

Table 3.6 LUR for rainfed summer corn and winter corn

Land qualities	Diagnostic land characteristics	S1	S2	S3	N
Sufficiency of water	-Rainfall (mm)	1200-1800	1000-1200	600-800	<600
	-Soil drainage class	Moderately drained	Moderately drained, well drained	Well drained	Poorly drained
	-Soil depth (cm)	>100	80-100	40-80	<40
Sufficiency of nutrients	-pH	5.5-7	4.5-5.5 7-8.5	4.5-4 8.5-9.0	<4 >9.0
	-OM	>2.0	1-2.0	1-0.5	>0.5
Ease to control erosion hazard	Slope (degree)	0-5	5-10	10-25	>25
Ease of cultivation	Stone and rock outcrop (%)	0-5	5-10	10-15	>15

Table 3.7 LUR for rainfed sugar cane

Land qualities	Diagnostic land characteristics	S1	S2	S3	N
Sufficiency of water	-Rainfall (mm)	1600	1100-1600	900-1100	<900
	-Soil drainage class	Moderately drained	Moderately drained, Well drained	Well drained	Poorly drained
	-Soil depth (cm)	>100	80-100	40-80	<40
Sufficiency of nutrients	-pH	5.5-7	4.5-5.5 7-7.5	4.5-4 7.5-8	<4 >8
	-OM (%)	>2.5	1-2.5	0.5-1	>0.5
Ease of water control	Slope (degree)	0-5	5-10	10-20	>20
Ease of cultivation	Stone and rock outcrop (%)	0	1-5	5-10	>10

Table 3.8 LUR for rainfed rubber

Land qualities	Diagnostic land characteristics	S1	S2	S3	N
Sufficiency of water	-Rainfall (mm)	>1700	1400-1600	1200-1400	<1200
	-Soil drainage class	Moderately drained	Well drained	Well drained	Poorly drained
	-Soil depth (cm)	>100	80-100	50-80	<50
Sufficiency of nutrients	-pH	5.5-6.5	4.5-5.5 6.5-7	3.5-4.5 7-8	<3.5 >8
	-OM (%)	>3	2.5-3	2-2.5	>2
Ease of erosion hazard	Slope (degree)	0	1-5	5-10	>10
Ease of cultivation	Stone and rock outcrop (%)	0	0-5	5-10	>10

Table 3.9 LUR for rainfed cashew

Land qualities	Diagnostic land characteristics	S1	S2	S3	N
Sufficiency of water	-Rainfall (mm)	>1500	1200-1500	1000-1200	<1000
	-Soil drainage class	Moderately drained, well drained	Well drained	Poor drained	Poor drained
	-Soil depth (cm)	>100	80-100	50-80	<50
Sufficiency of nutrients	-pH	5-6	4-5 6-7	3-4 7-8.5	<3 <8.5
	-OM	>2	1 –2	1-0.5	<0.5
Ease of erosion hazard	Slope (degree)	0-5	5-10	10-15	>15
Ease of cultivation	Stone and rock outcrop (%)	0	0-10	10-20	>20

Table 3.10 LUR for rainfed rambutan

Land qualities	Diagnostic land characteristics	S1	S2	S3	N
Sufficiency of water	-Rainfall (mm)	>1800	1800-1600	1600-1300	<1300
	-Soil drainage class	Moderately drained,	Well drained	Well drained	Poorly drained
	-Soil depth (cm)	>100	80-100	50-80	<50
Sufficiency of nutrients	-pH	>5	5-4 7-8	4-3 8-9	<3 >9
	-OM	>3.5	2.5-3.5	1.5-2.5	>1.5
Ease of erosion hazard	Slope (degree)	0	0-5	5-10	>10
Ease of cultivation	Stone and rock outcrop (%)	0	0-5	5-10	>10

3.9 Selecting land quality

The comparison between LQ and LUR required at least 5 land qualities. They were selected by properties that influence crop yield, occurrence of critical value and obtainable information. The selected LQs in this evaluation were integrated into evaluation process with weight factor by using multi-criteria evaluation.

3.10 Physical suitability

The process of physical suitability evaluation follows the Multi-criteria evaluation procedure as in Figure 3.7. Criteria used consist of rainfall, slope, soil drainage, depth, pH, OM, and quantity of stones found on the surface land.

The values in factor maps were standardized to have the new values ranging from 0-1.0 according to the values of fuzzy set membership. This is represented by the value of Xi in equation (2). The higher the value is the higher suitability score except for the slope factor map and stoniness are vice versa.

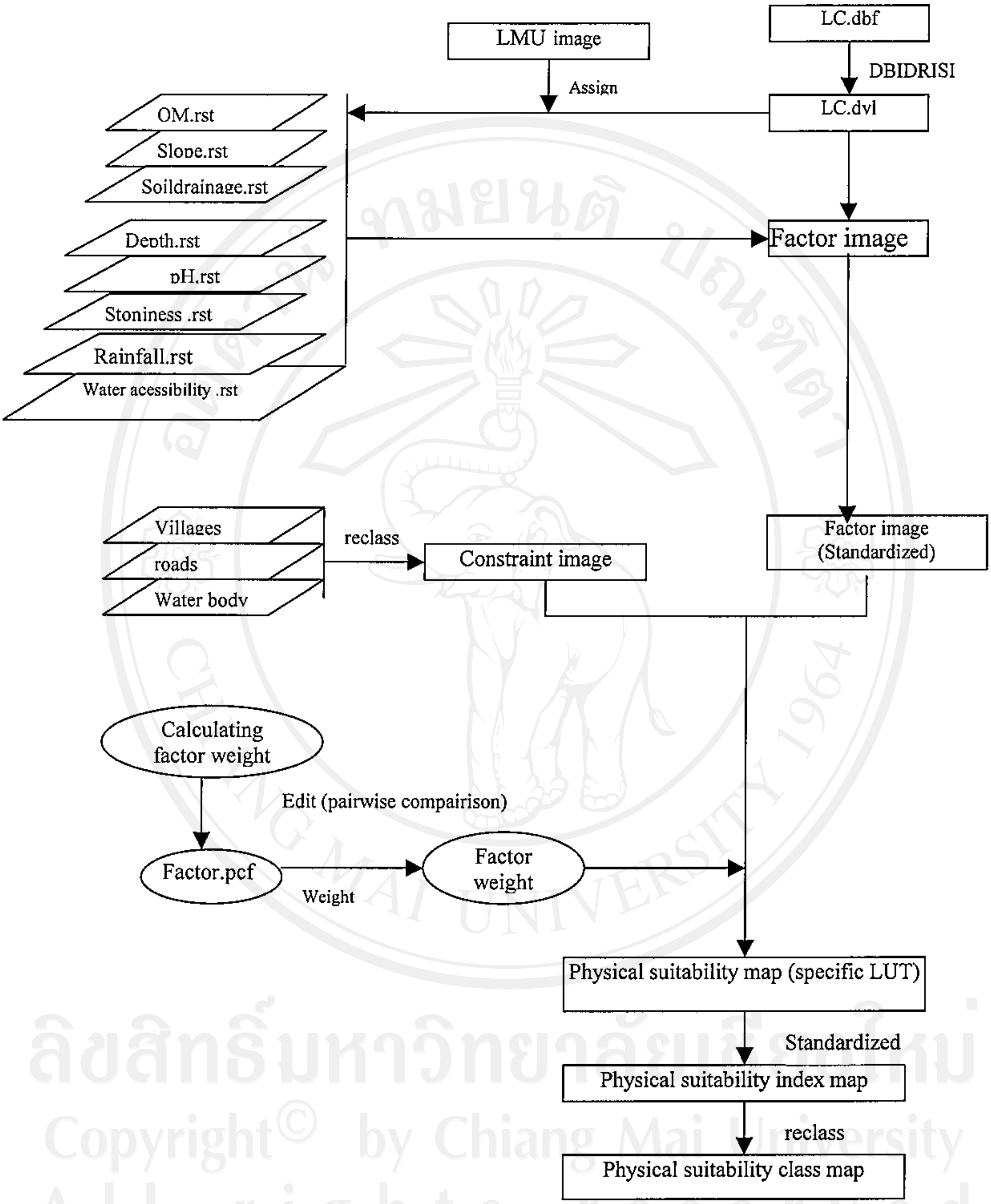

Figure 3.7 Multi-criteria evaluation procedure

Constraint maps in the study were created from the areas that could not be used for the cultivation such as roads, water bodies and villages. These areas were assigned the value of 0 in the constraint map, hence the value of C_j in equation (2).

In the procedure for multi-criteria evaluation using the weighted linear combination, a pairwise comparison in AHP method was applied for the assigning the weight for each factor. They were derived by taking the principle eigenvector of square reciprocal matrix of pairwise comparison between criteria (Saaty, 1977). The comparison concern the relative importance of each pair of criteria related to determining suitability for objective. The ratings were provided on a 9-point continuous scale (Figure 3.8).

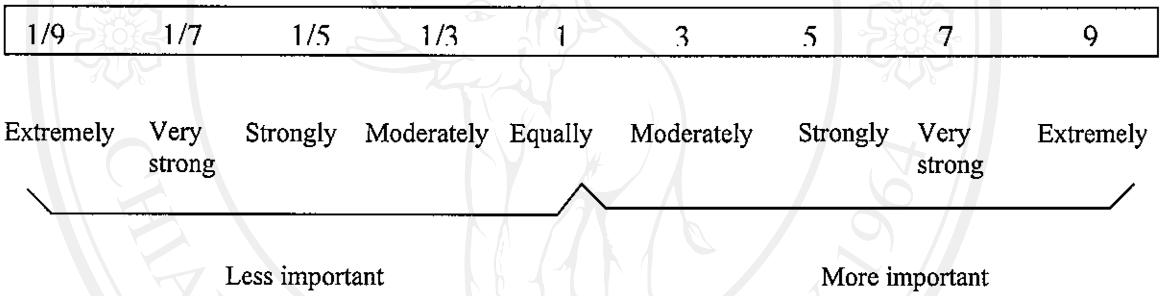

Figure 3.8 The continuous rating scale

In Idrisi software, EDIT command with pairwise comparison was used to compute the weight of each factor, Wi in equation (2) for each LUT.

Multi Criteria Evaluation (MCE) command was used to combine the factors and constraints with weighted linear combination to obtain the value for suitability scores (S) in equation (2). The procedure was optimized for speed and had the effects of multiplying each factor by its weight, adding the results and multiplying the result by each of constraint (Eastman, 1993).

The result of this selected LUTs were the suitability scores for each LUT. The scores were standardized to have the ranges between 0- 1.0 in order to express a suitability index map.

3.11 Land allocation for LUTs

The physical land suitability indexes of all crops were overlayed together to obtain the relative land suitability. Then, these indices were multiplied by weights of economic priority (W_j) for crops to obtain the relative suitability for land allocation. In each pixel, the value was expressed as a result of selected the maximum value of all crops and that value was coded as crop or cropping system to display the final suitability land allocation class for crop or cropping system that was allocated to each grid cell. This process was done by the combination of Excel and Idridsi softwares to link between the attribute table and the map.

The weights of economic priority were based on net benefit cost ratio (NBCR) for each crop. NBCR was calculated based on total variable cost and net benefit generated from gross margin analysis for corn-corn, sugar cane and discounted cash flow analysis for rubber, cashew and rambutan. The process of land allocation for LUTs was shown in Figure 3.9. Rice-rice cropping system was not included in calculation of relative weights for LUTs in selecting highest score for crops because of local policy. Rice-rice area was defined by land suitability excluding non suitable area for rice-rice cropping system on irrigated area.

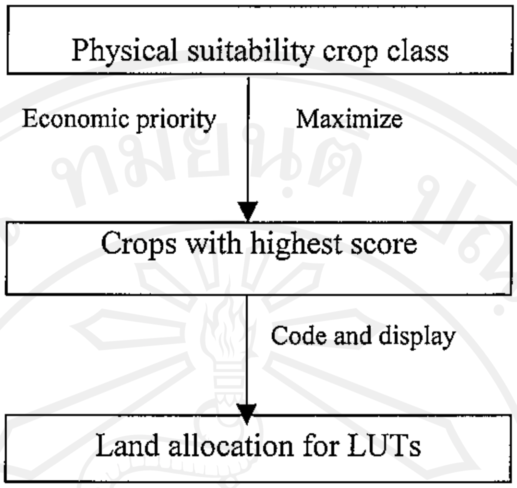

Figure 3.9 Land allocation for LUTs