2^{nd} Progress Report

of

Decision Support for Mainstreaming and Scaling up Sustainable Land Management (DS-SLM)

THAILAND

By

Land Development Department

Ministry of Agriculture and Cooperatives

June 2019

Supporting the budget proposal of GEF and Food and Agriculture Organization of the United Nations (FAO) for the fiscal year 2019

Module 2 National and Subnational Level Assessment

And

Module 3 Selection of Priority Landscape

Produce Land Use System Map (LUS) and generate Land Degradation Map (LD)

of Thailand

Land Use Planning Division and Regional Office 1-12

1. Introduction

Land and water resources are the foundation for agricultural production, aquaculture, fisheries that provide income and other products for people in Thailand. Furthermore, ecosystem services associated with land and water provide crucial benefits to both rural and urban population. However, some areas are fragile regarding the problem soil such as shallow soil, saline soil and erosion hazard and those problems cause degradation and affect to livelihood of people.

Therefore, it is necessary to estimate the land degradation and provide information for identifying the degraded and vulnerable land areas by applying the knowledge, tools and methodology created by LADA, FAO to generate Land Use System and Land degradation map of Thailand. This will help to assist government to mitigate land degradation and support the sustainable land management program in Thailand.

2. Objectives/Goal

- To produce Land Use System Map (LUS) of Thailand by following framework of LADA project.

- To generate Land Degradation Map (LD) from LUS map and Mapping Questionnaire (QM) table and then contribute to the process of Local Assessment

3. Outputs

- National Land Use System Map

- Land Degradation Map

- Final report of the end of project

4. Steps of Work

4.1 Project planning: establish goal, define problem, scope of work, available data needed for the project, responsible person, timeframe, and budget.

4.2 Data gathering: collect relevance data from different sources such as Land Development Department, Office of Statistic, Royal Forest Department, Department of National Parks, Wildlife and Plant Conservation, Department of Irrigation, Agricultural Land Reform, Department of Provincial Administration etc.

4.3 Training on National/Subnational Land Degradation Assessment (LADA): study methodology following LADA Framework for LUS and LD map preparation.

4.4 Preparation of LUS:

- analyze data using GIS by overlaying selected available map and consisting of soil group, land use, forest dictated by laws, national park, wildlife sanctuary, Irrigation, administrative boundary.
- classify overlaid data into 12 land use systems based on data; Forest protected, Forest protected with disturbed activities, Agricultural- rainfed upland rice, Agricultural- rainfed lowland rice, Agricultural- rainfed upland field crops/ perennials, Agricultural- rainfed lowland field crops/ perennials, Agricultural- irrigated upland rice, Agricultural- irrigated lowland rice, Agricultural- irrigated upland field crops/ perennials, Agricultural- irrigated lowland field crops/perennials, Urban and Water.

4. 5 Generate Land Degradation Map by linking between LUS map prepared by Land Use Planning Working Group and QM table filled up by experts in 12 regional offices and consider rate and degree of land degradation for generating land degradation map.

4.6 Field validation by conducting survey for ground validation to correct the LUS map and LD map in 4 regions and cover all 12 land use systems.

4.7 Writing report: prepare final report of the end of final project.

5. Work plan for Land Use Planning Working Group

ACTIVITIES AND OUTPUTS	TIMEFRAME							
	2018				2019			
	9	10	11	12	1	2	3	4
5.1 Project planning: define problem, scope of work, person etc.	**X**	**X**						
5.2 Data gathering: relevance data from different sources	**X**	**X**						
5.3 Training on National/Subnational Land Degradation Assessment								
5.4 Preparation of LUS: analyze data using GIS, classify LUS		**X**	**X**					
5.5 Generate land degradation map based on LUS map and QM table		**X**	**X**	**X**	**X**	**X**		
5.6 Field validation: conduct ground validation			**X**	**X**	**X**	**X**		
5.7 Writing final report of the end of project							**X**	

6. Methodology

The overall methodology includes materials and major analysis. The processing of LUS and LD maps is presented in Figure 1. Required data type, their sources and methods are described below.

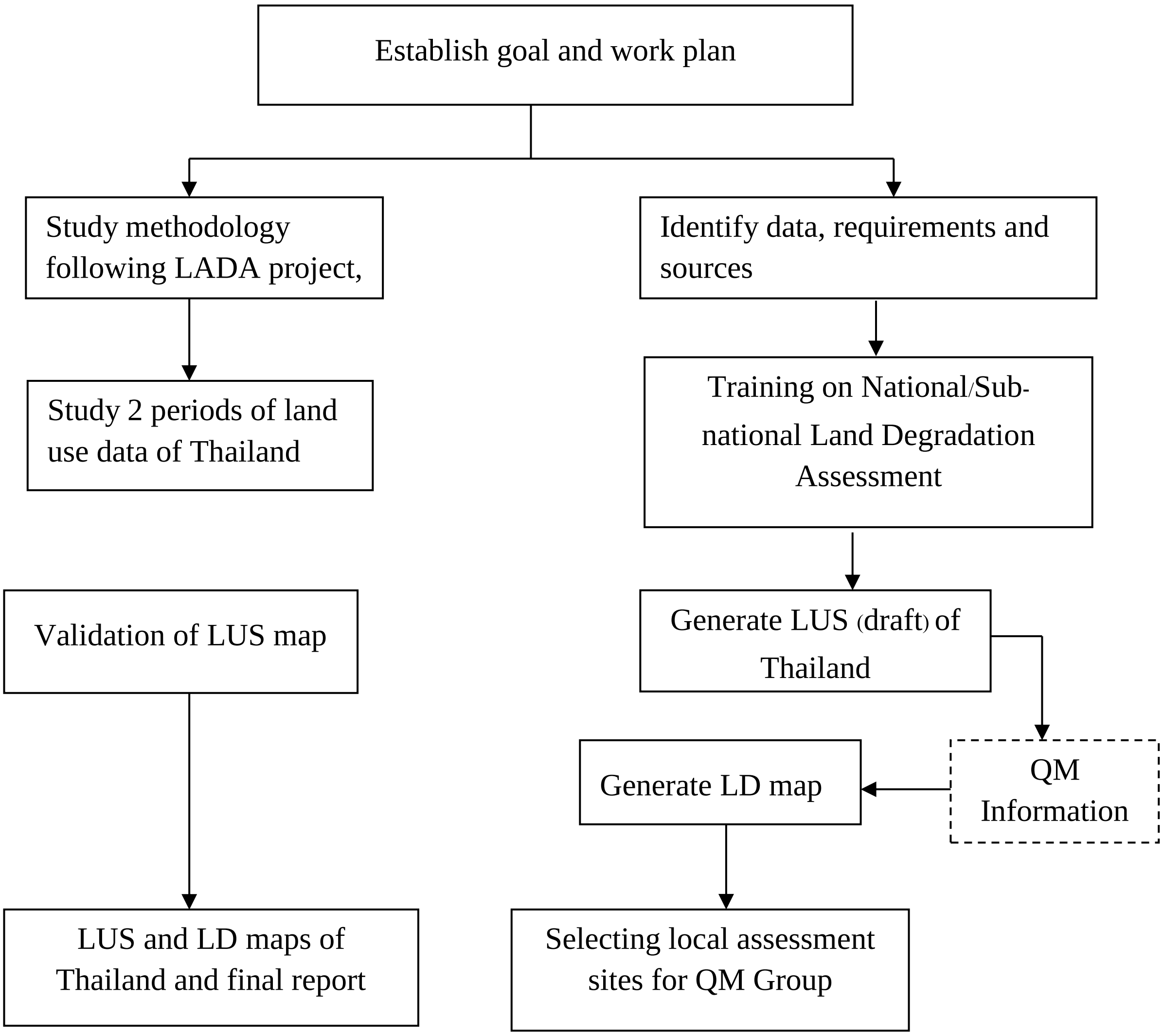


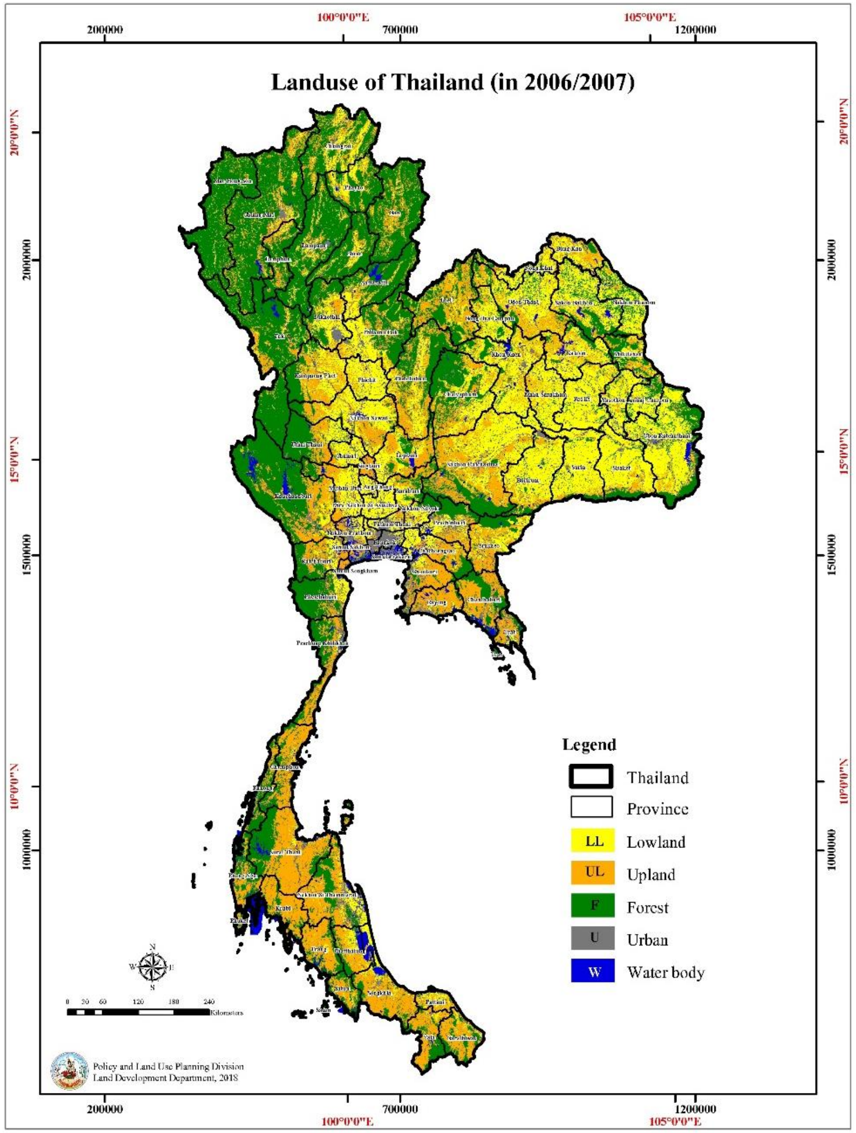
Figure 1 Flow chart of LUS and LD processes

6.1 Data Preparation for the Land Use Systems and Land Degradation maps

The national land use systems mapping was conducted using LADA methodology. The first step was identified the LUS parameters such as major ecosystem, land use, biophysical and socio-economic attributes. Land use planning working group worked on the preparation of LUS map by collected agreed datasets need in shape files format, which are presented in Table 1.

Table 1: Data needs for producing LUS and LD maps

Data	Description	Year	Source
Land use maps	Land use/land cover map Scale 1:250,000	2006, 2015	Land Development Department (http://ldd.go.th)
Protected area map	The area that consider to protect because of their recognized natural, wildlife or dedicated and managed through legal, which contains information on the National Forest of Thailand, the Conservation areas of National Parks, Wildlife and Plant Conservation, the Mangrove areas of Thailand, and the areas of Agricultural Land Reform.	2016	- Royal Forest Department - Department of National Parks - Wildlife and Plant Conservation - Agricultural Land Reform Department - Department of Marine and Coastal Resources
Irrigation map	Irrigation contributes to a point of interest where the share of water reach the fields	2015	Royal Irrigation Department
Soil map	Soil data to consider as the layer of upland and lowland areas	2016	Land Development Department (http://ldd.go.th)
Problem Soil map	Consist of soil erosion map, acid sulphate soils map, and salt affected soils map	2016	Land Development Department (http://ldd.go.th)
Questionnaire survey data	A table of information on analysis of percentage of LUS and percentage of land degradation problems	2018	Expert knowledge and field observation



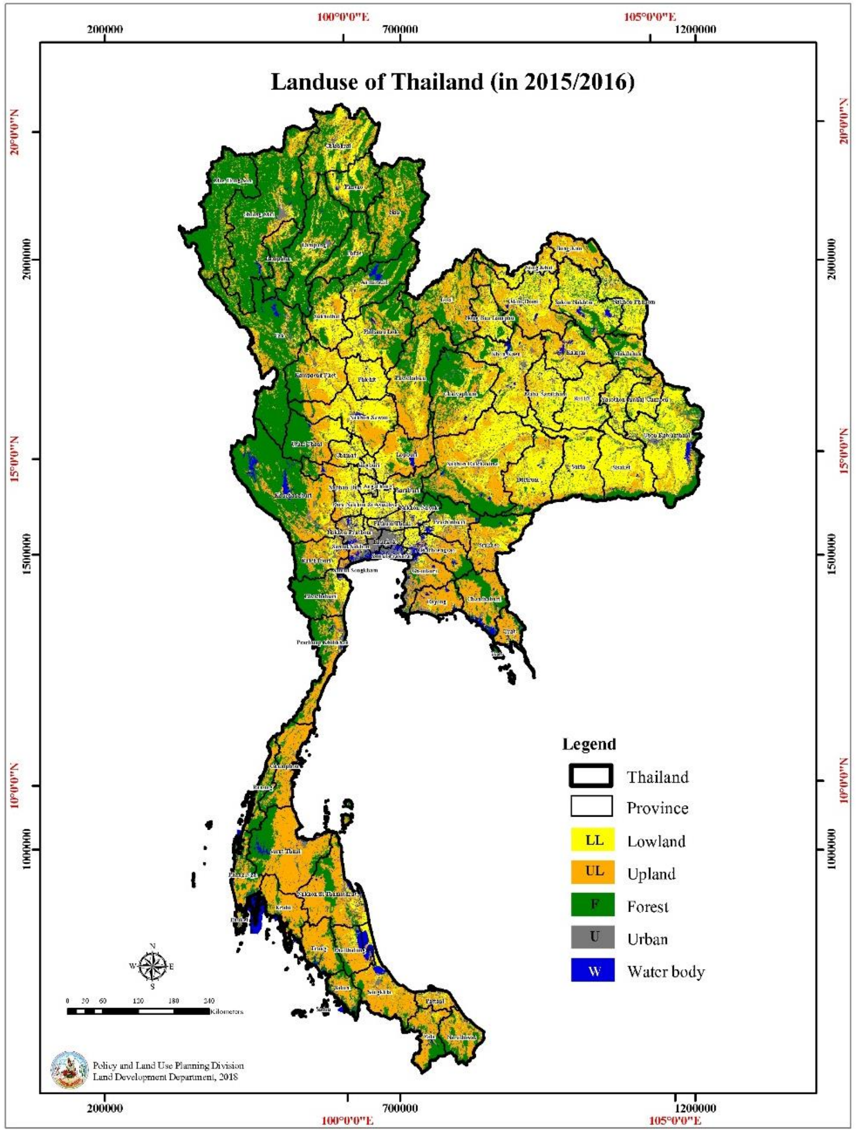


Figure 2 Land use of the year 2006 and 2015

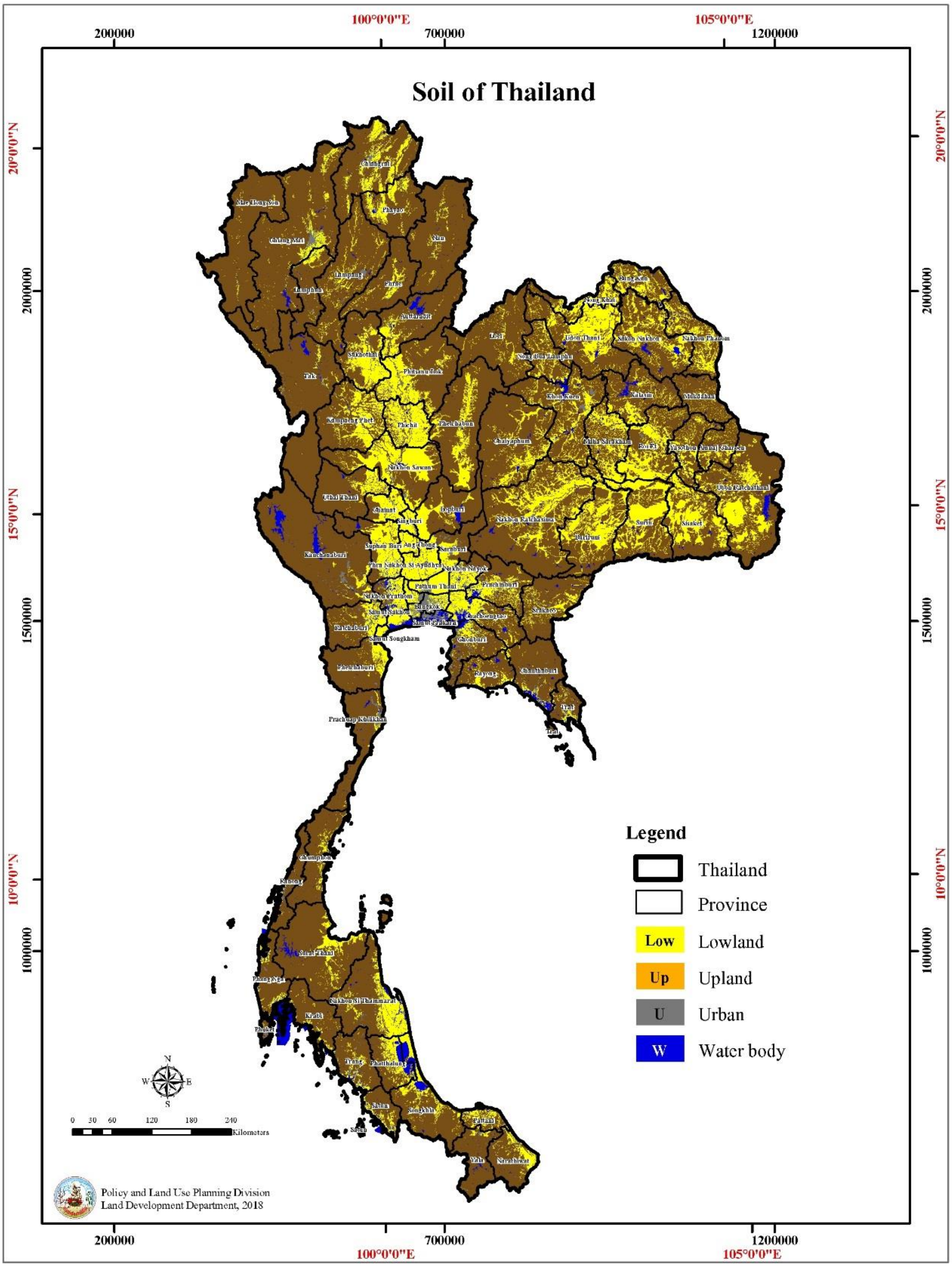


Figure 3 Upland and Lowland areas of Thailand

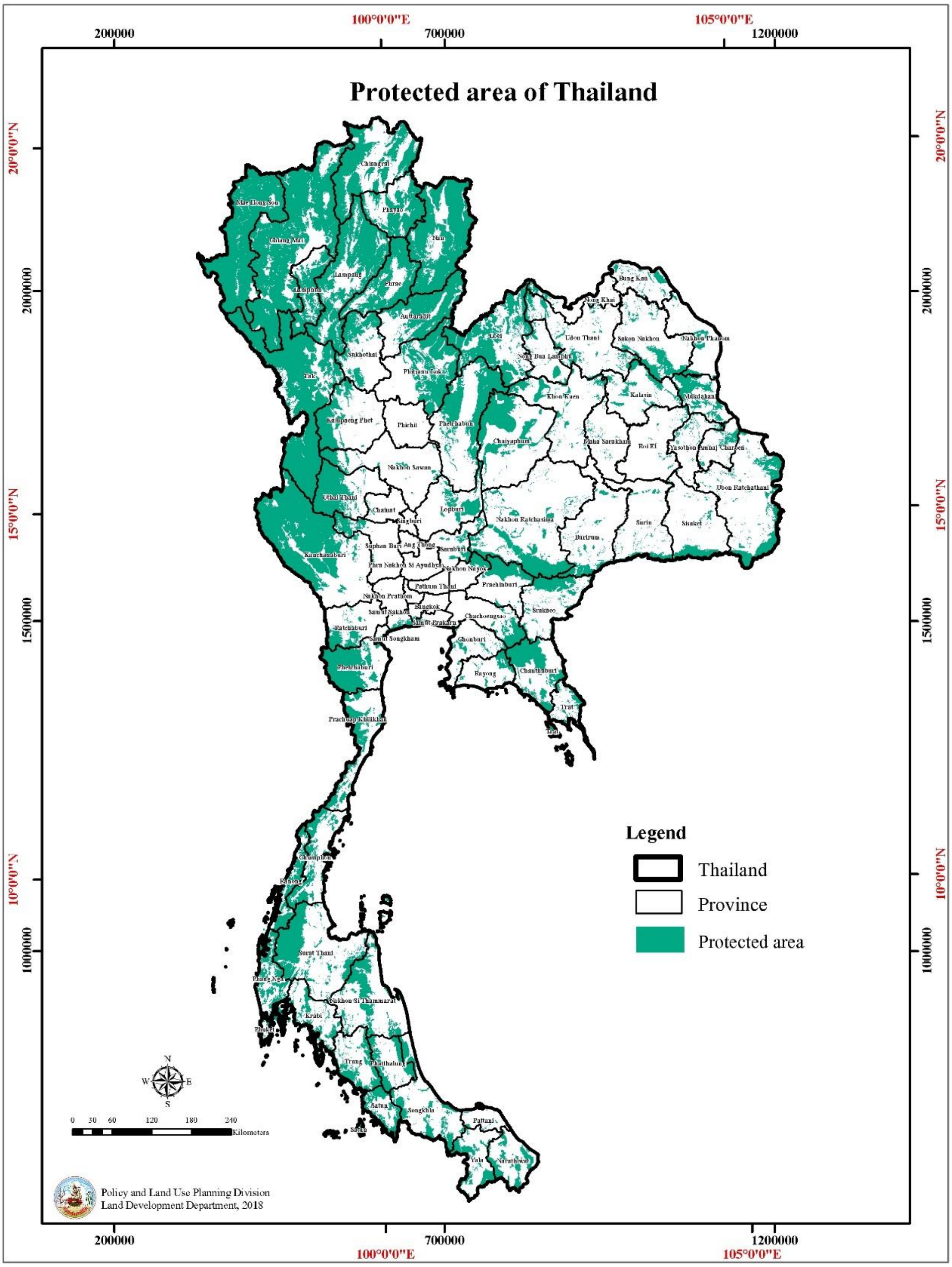


Figure 4 Protected area in Thailand

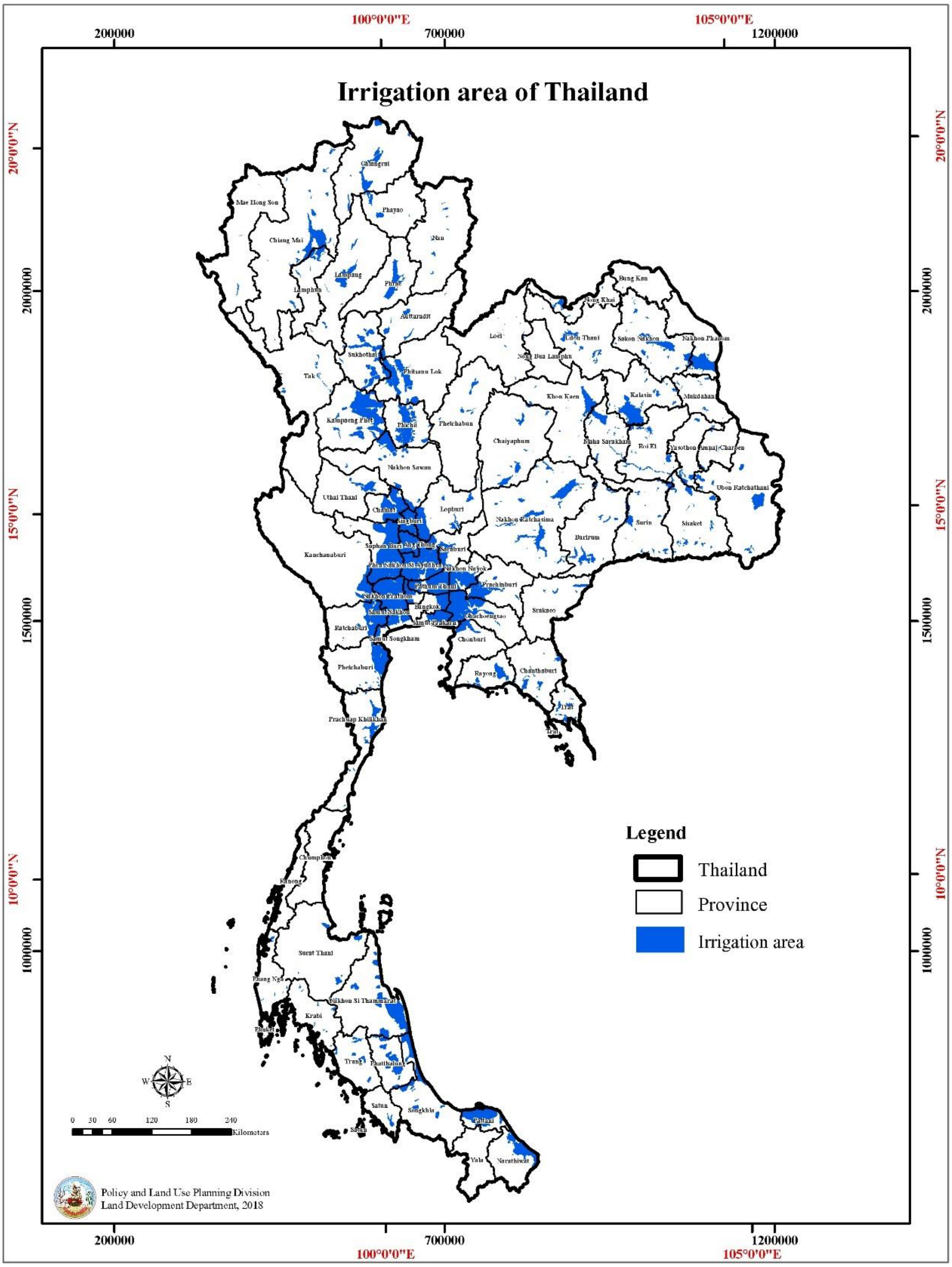


Figure 5 Irrigation areas of Thailand

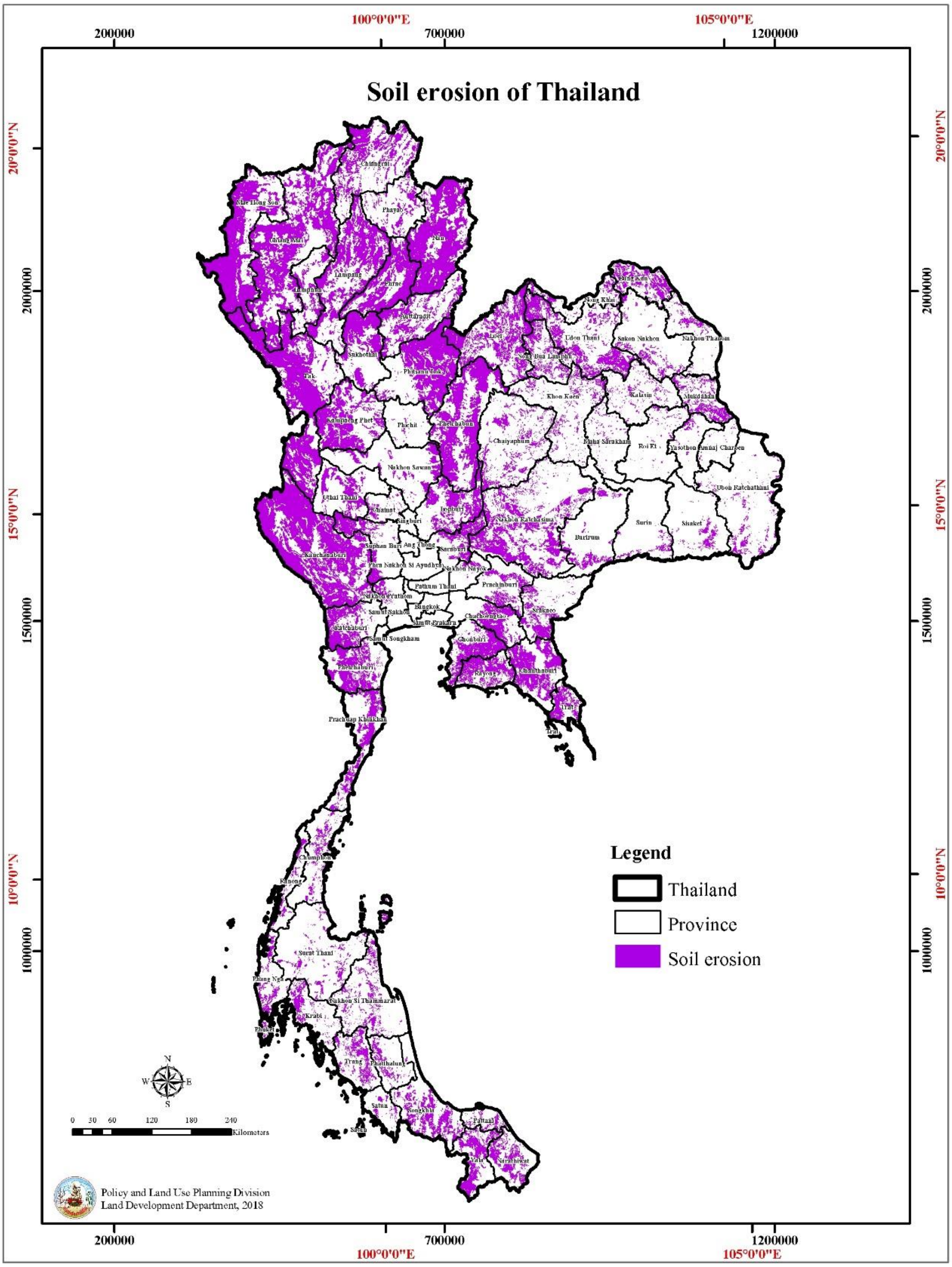


Figure 6 Soil erosion map of Thailand

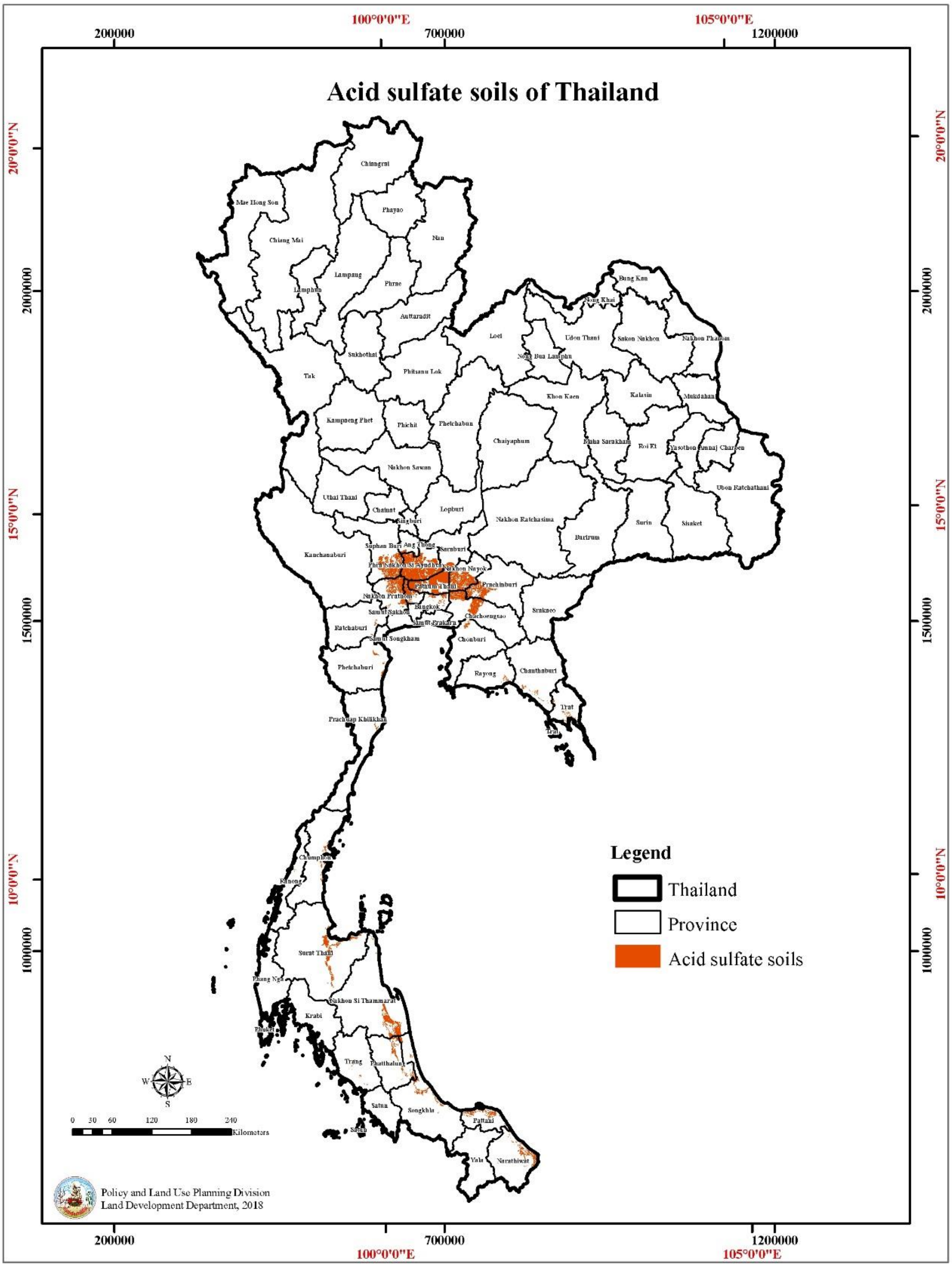


Figure 7 Acid sulfate soils map of Thailand

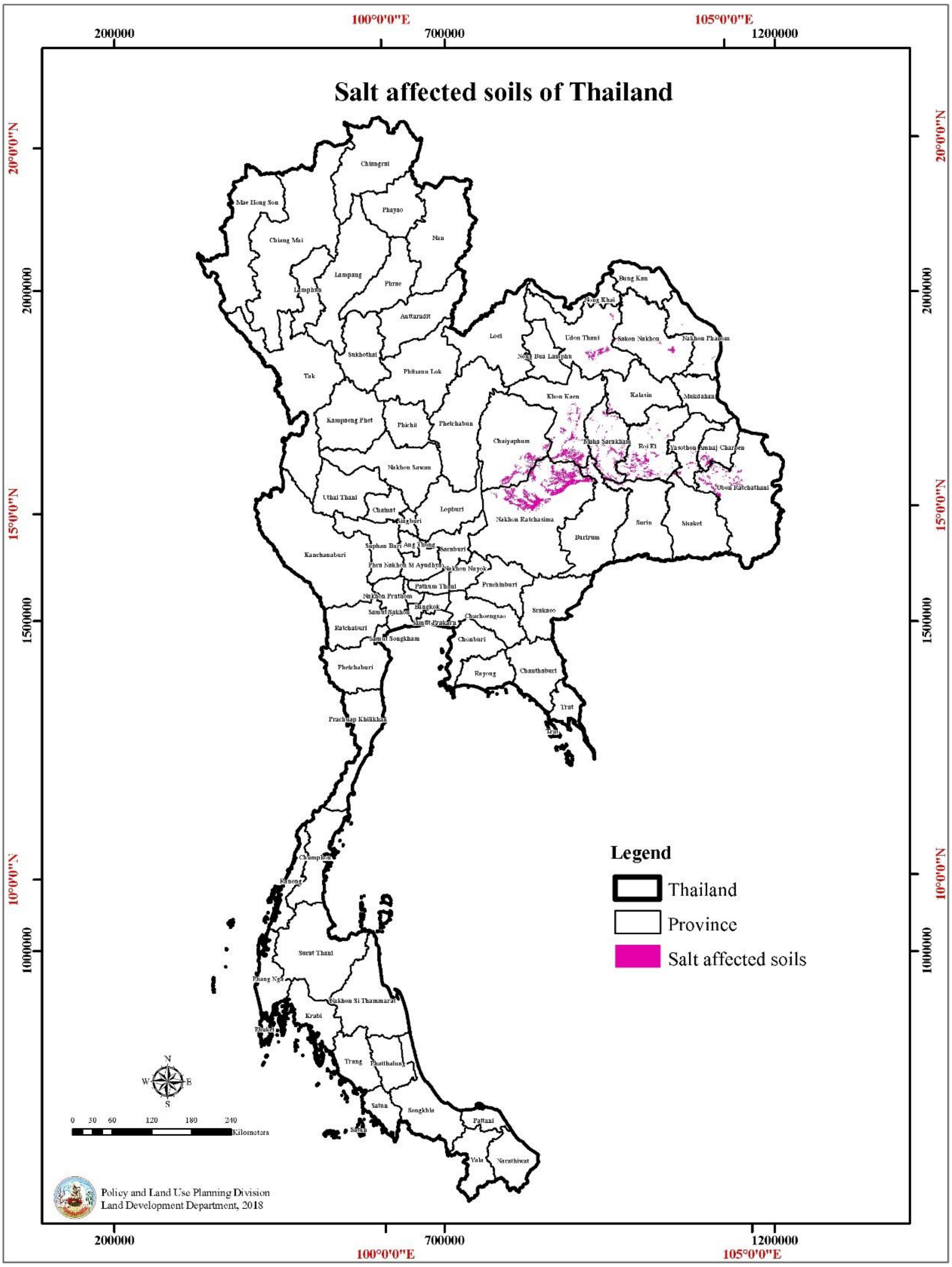


Figure 8 Salt affected soils map of Thailand

6.2 Mapping Procedure

1) Analyze land use map of the two years according to land use condition data (Table2).

Table 2: Conditions for Analyzing and Mapping of Land Use Systems in Thailand

LUS CODE	Land Use System Unit	Landuse class	Protected area	IRR	Soil
1	Forest - protected	F	Y/N	Y/N	Up/Low
2	Forest - protected with disturbed activities	UL/LL/U	Y	Y/N	Up/Low
3	Agriculture - rainfed upland rice	LL	N	N	Up
4	Agriculture - rainfed lowland rice	LL	N	N	Low
5	Agriculture - rainfed upland field crops/Perennials	UL	N	N	Up
6	Agriculture - rainfed lowland field crops/Perennials	UL	N	N	Low
7	Agriculture - irrigation upland rice	LL	N	Y	Up
8	Agriculture - irrigation lowland rice	LL	N	Y	Low
9	Agriculture - irrigation upland field crops/Perennials	UL	N	Y	Up
10	Agriculture - irrigation lowland field crops/Perennials	UL	N	Y	Low
11	Urban land	U	N	Y/N	U
12	Water body	W	Y/N	Y/N	W

Note: Y = there is condition in land use system unit.
N = there is no condition in land use system unit.
Y / N = can be both conditions
F = Forest
UL = Upland
LL = Lowland
U = Urban
W = Water

2) Analyze of percentages of land use change for 2006 and 2015 by using the following formula: ((Recently LUS – Previous LUS)/ Previous LUS)* 100

3) Compute the percentage of change of land use system then data was classified to different classes based on the criteria in Table 3

Table 3 Criteria of classifying the change of LUS

Area trend	Description and criteria for classifying the change of LUS
2	Rapidly increasing of LUS (>10% of LUS within 10 years)
1	Slowly increasing of LUS (<10% of LUS within 10 years)
0	No change
-1	Slowly decreasing of LUS (<10% of LUS within 10 years)
-2	Rapidly decreasing of LUS (>10% of LUS within 10 years)

4) Analyze the percentage of area covered by degradation area which consists of three (3) problems; soil erosion, acid sulfate soil and saline soil. These problems were considered and

discussed among the participants during the National/ Subnational Land Degradation Assessment under Decision Support for Mainstreaming and Scaling up of Sustainable land between 5 – 9 June 2018

5) Create Land Use System Map together with questionnaire table (QM Table) for preparing land degradation map and sustainable land management of each province and then the questionnaires were filled up by the expert of each regional office after considering and assessing the land degradation in each LUS (Table 4)

6) Determine the demonstration sites, after the expert of each regional office assessed the land degradation and filled up the QM Table then these questionnaires were sent back to the Land Use Planning Working Group for preparing rate and degree of Land Degradation Map. These maps would be used in the step of selecting sites for demonstration and scaling up the decision support system for sustainable land management.

7. Results

Following FAO framework and LADA assessment methodology, there are two theoretical systems resulted as describe in section below

7.1 Land Use Systems

Land Use Systems (LUS) are the most suitable units that capture the status and causes that influence land degradation and sustainable land management interventions. At national scale, Land use systems of Thailand are used as a reference at local scale, which is a standardized and improved method for land degradation assessment, with guidelines for their implementation. Land use systems area of Thailand is shown in Table 5. It showed that the most area was in Forest – protected unit which covered 34% of total area follow by Agriculture - rainfed upland field crops/perennials unit and Agriculture - rainfed lowland rice unit, which covered 19.48% and 8.76%, respectively.

Table 5 Land Use System Area of Thailand

LUS code	Land use systems unit	Area	
		ha	%
1	Forest - protected	17,531,611	34.00
2	Forest - protected with disturbed activities	4,232,349	8.21
3	Agriculture - rainfed upland rice	4,404,261	8.54
4	Agriculture - rainfed lowland rice	4,515,179	8.76
5	Agriculture - rainfed upland field crops/perennials	10,047,877	19.48
6	Agriculture - rainfed lowland field crops/perennials	986,311	1.91
7	Agriculture - irrigation upland rice	415,960	0.81
8	Agriculture - irrigation lowland rice	3,311,035	6.42
9	Agriculture - irrigation upland field crops/perennials	514,747	1.00
10	Agriculture - irrigation lowland field crops/perennials	369,025	0.71
11	Urban land	3,306,315	6.41
12	Water body and Aquaculture	1,933,976	3.75
Total		51,568,646	100.00

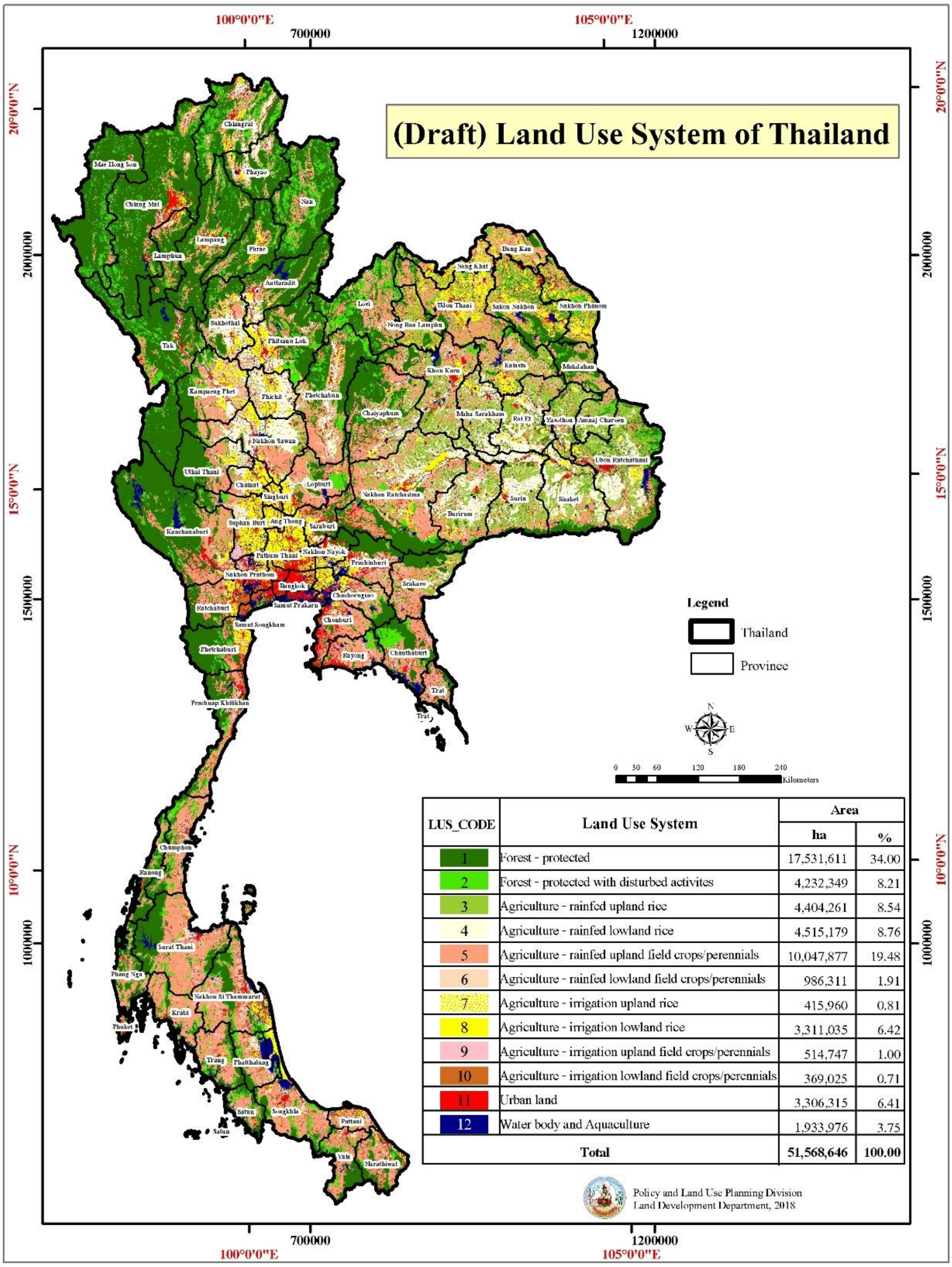
Table 4 Questionnaire for formulating land degradation map and sustainable land use management together with analysis of percentage of LUS and percentage of land degradation problems

			LUS (step 2)			Land degradation (step 3)												
Adm_Name	Admin_Code	LUS_Name	LUS_Code	LUS_ADM_C	AreaTrend	Type_1	Percent_T1	Type_2	Percent_T2	Type_3	Percent_T3	Extent	Degree	Rate	DiCauses	IndiCauses	ImpEcoServ	DegRemarks
Phetchaburi	76	Forest - protected	1	7601	-1	erosion	10											
Phetchaburi	76	Forest - protected with disturbed activites	2	7602	2	erosion	36.23	acid sulfate soil	0.1									
Phetchaburi	76	Agriculture - rainfed upland rice	3	7603	-2	erosion	8.48											
Phetchaburi	76	Agriculture - rainfed lowland rice	4	7604	-2	erosion	15.14	acid sulfate soil	2.08									
Phetchaburi	76	Agriculture - rainfed upland field crops/perennials	5	7605	2	erosion	54.23											
Phetchaburi	76	Agriculture - rainfed lowland field crops/perennials	6	7606	2	erosion	58.01											
Phetchaburi	76	Agriculture - irrigation upland rice	7	7607	-1	erosion	5.51	-	-									
Phetchaburi	76	Agriculture - irrigation lowland rice	8	7608	-1	erosion	0.56	acid sulfate soil	7.72									
Phetchaburi	76	Agriculture - irrigation upland field crops/perennials	9	7609	2	erosion	48.18											
Phetchaburi	76	Agriculture - irrigation lowland field crops/perennials	10	7610	2	erosion	5.86	acid sulfate soil	8.07									
Phetchaburi	76	Urban land	11	7611	-													
Phetchaburi	76	Water body	12	7612	-													

Table 3 Continued…

	Conservation (step 4)														Expert recommendation (step 5)	
LUS_Name	Cons_ Name	Group	Measure	Purpose	Percent Area	Deg Address	Effect ive	EffTrend	Impac t ESS	Period	Ref. to QT	Con Remar ks	Exp ert Rec 1	Add Remar k1	Expert Rec2	Add Remark2
Forest - protected																
Forest - protected with disturbed activites																
Agriculture - rainfed upland rice																
Agriculture - rainfed lowland rice																
Agriculture - rainfed upland field crops/perennials																
Agriculture - rainfed lowland field crops/perennials																
Agriculture - irrigation upland rice																
Agriculture - irrigation lowland rice																
Agriculture - irrigation upland field crops/perennials																

Agriculture - irrigation lowland field crops/perennials																
Urban land																
Water body																



LUS_CODE	Land Use System	Area	
		ha	%
1	Forest - protected	17,531,611	34.00
2	Forest - protected with disturbed activites	4,232,349	8.21
3	Agriculture - rainfed upland rice	4,404,261	8.54
4	Agriculture - rainfed lowland rice	4,515,179	8.76
5	Agriculture - rainfed upland field crops/perennials	10,047,877	19.48
6	Agriculture - rainfed lowland field crops/perennials	986,311	1.91
7	Agriculture - irrigation upland rice	415,960	0.81
8	Agriculture - irrigation lowland rice	3,311,035	6.42
9	Agriculture - irrigation upland field crops/perennials	514,747	1.00
10	Agriculture - irrigation lowland field crops/perennials	369,025	0.71
11	Urban land	3,306,315	6.41
12	Water body and Aquaculture	1,933,976	3.75
Total		51,568,646	100.00

7.2 Land Degradation

Results from the assessment of land degradation by the expert in each regional office showed the problems of land degradation mainly come from soil erosion by water for example, erosion caused by loss of topsoil (Wt), collapse of river bank (Wr), mudslide (Wm) etc., soil chemical degradation such as acid sulfate soil/acid soil (Ca), saline/alkaline soil (Cs) and decrease of organic matters and soil fertility (Cn) etc., biological degradation for example, effect of wildfire (Bf), increase of insect pest and decease (Bp), and decrease of biomass (Bq) etc. Furthermore, pack soil (Pc) and quality of surface water (Hp) was also found.

Regarding the land degradation problems, the expert assessed rate and degree of land degradation of each LUS in each province and then, analyzed for creating land degradation map. Results showed severe land degradation mostly found in Forest-protected area in Tak, Kampaengphet, Uthaithani, and Nakonratchasima Provinces.

Based on the rate and degree of land degradation in Thailand, hotspot and brightspot were indicated for scaling up Sustainable Land Management (SLM). There were selected hotspots and brightspots for saline soil, erosion and acid sulfate soil. Both hotspot and brightspot were found in Nakonratchasima province for saline soil. For erosion, Chiangmai Province showed the hotspot and the brightspot was indicated in Phetchabun Province. Whilst for acid sulfate soil, hotspot was shown in Songkla Province and brightspot was selected in Nakonsrithammarat Province.

Table 6 Degree Area of land degradation

Degree	Description	Area	
		ha	%
1	Light	13,711,806	26.59
2	Moderate	22,251,331	43.15
3	Strong	7,630,467	14.80
4	Extreme	2,734,751	5.30
N/A	Not available (urban land, water body and aquaculture etc.)	5,240,291	10.16
Total		51,568,646	100.00

Table 7 Rate Area of land degradation

Rate	Description	Area	
		ha	%
3	Rapidly increasing degradation	1,890,916	3.67
2	Moderately increasing degradation	11,165,861	21.65
1	Slowly increasing degradation	14,446,904	28.01
0	No change in degradation	5,290,592	10.26
-1	Slowly decreasing degradation	9,679,320	18.77
-2	Moderately decreasing degradation	3,854,762	7.48
N/A	Not available	5,240,291	10.16
Total		51,568,646	100.00

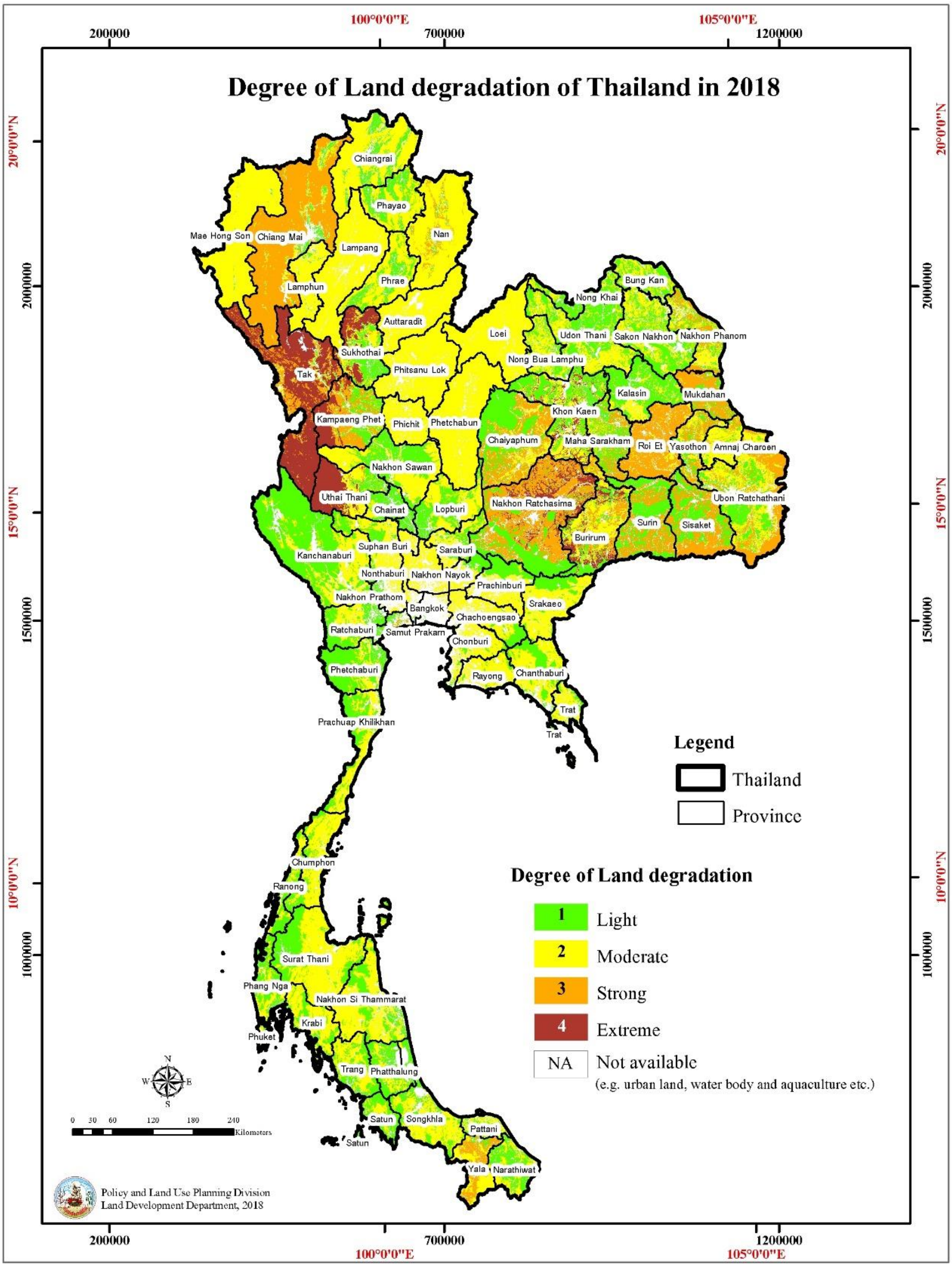


Figure 10 Degree of land degradation of Thailand in 2018

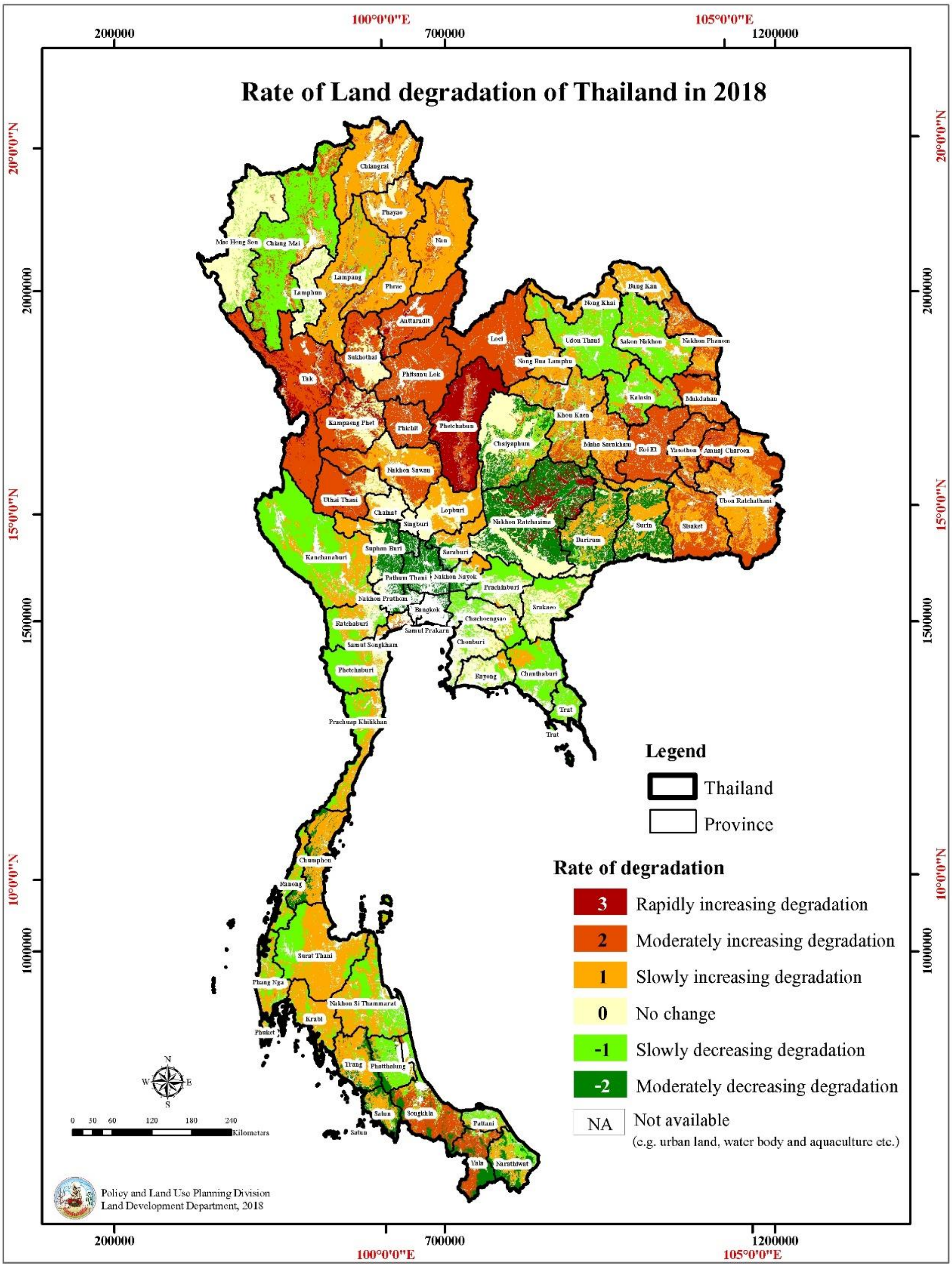


Figure 11 Rate of land degradation of Thailand in 2018

References

FAO.2013. Land Degradation Assessment in Drylands. Mapping land use systems at global and regional scales for land degradation assessment analysis. *Version 1.1.* Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO.2013. Land Degradation Assessment in Drylands. Questionnaire for mapping land degradation and sustainable land management (QM). *Version 2.* Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO.2013. Land Degradation Assessment in Drylands. Methodology and results. Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO.2016. Land Degradation Assessment in Drylands. Manual for local level assessment of land degradation and sustainable land management. *Part 1 Planning and methodological approach, analysis and reporting.* Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO.2016. Land Degradation Assessment in Drylands. Manual for local level assessment of land degradation and sustainable land management. *Part 2 Field methodology and tools.* Food and Agriculture Organization of the United Nations, Rome, Italy.

Module 4 Landscape Level Assessment

Progress report of assessing natural resources degradation related to local land use for the issue of soil erosion

Karn Trisopon, Kulvadee Sutawat, and Pranee Srihaban

Introduction

Land Development Department is the main agency to operate the project "Decision Support for Mainstreaming and Scaling up of Sustainable Land Management (DS-SLM)" with Food and Agriculture Organization of United Nations (FAO). It has planned to operate the DS-SLM project during 2018-2019. This project is financially supported by Global Environment Facility (GEF) under the cooperation of Food and Agriculture Organization (FAO) together with 15 participatory countries. The objectives are to combat land degradation and drought at the global level by making the measures/best practices of sustainable land management widely well-known and accepted. Moreover, operating the activities of land management has been promoted for using resources sustainably at the regional level in order to prevent the impact from desertification, land degradation and drought. The data base development of the measure of sustainable land management (SLM) of the United Nations Convention to Combat Desertification (UNCCD) has also been supported, including the data useful to driving sustainable development goals (SDGs).

The project of Local Land Degradation Assessment is an ongoing project operating by bringing the outcome of the land degradation assessment based on Land Use Mapping system (LUS) and Mapping Question (QM) at the national level to be implemented at the local level. Working is divided into 3 groups. Each group is responsible for the main issue regarding the degradation of land resources in its own region in order to cover characteristics of land degradation of the whole country. Each group must survey the land in order to assess land resources in several aspects, namely

- Productivity interrelations,
- Crop Land,
- Range Land,
- Forest/ Woodland

The operation requires the assessment of problems, obstacles and challenges related to land degradation and drought. This also includes the principle of participatory working to find appropriate means to prevent, lessen the severity of and restore the impact of the problems of land and drought as well as scaling up the approach of practices to the policy level. The objective is to bring about support in terms of policies, budgets and cooperation in developing the potential to drive SLM activities to be systematic. This will bring about sustainability of national land use and the achievement from the operation will result in global benefits, namely increasing yields, green areas, carbon storage and water, including using water efficiently.

Objectives

1. To prepare the report of local degradation assessment
2. To assess local degradation, problems, obstacles and challenges related to soil resources, including building awareness of the importance of land degradation by using the principle of participatory working with stakeholders in using measures or guidelines which are efficient in managing land sustainably.
3. To determine the guideline of scaling up and pushing for solving the problem of land degradation and to implement SLM activities for bringing about local and national benefits.

Expected benefits

1. Giving an opportunity for the working group to promulgate the knowledge regarding the trend of land degradation particularly in agricultural areas in order to bring about exchanging knowledge, opinions and experiences related to factors stimulating the process of land degradation to occur continuously with the trend to increase severity
2. Obtaining guidelines and the pattern for promulgating, scaling up and pushing so that there will be actions for implementing sustainable land management appropriately with area conditions and the efficiency will be brought about in solving the problem of land degradation
3. The agencies involved with interests of government sectors and private sectors will obtain knowledge, understanding regarding the impact of land degradation and benefits obtained from sustainable land management, and the guideline to be used in order to bring about benefits in the area further.

Procedures of operation

1. Selecting areas-In case of Thailand, problems which are the source of soil resources are determined for 3 items, namely acid sulfate soil, saline soil and soil erosion. This report is the result of operating in the problematic part of soil erosion whereby the work area has been determined for the upper northern part of Thailand.
2. Determining transect lines in order to specify locations of collecting data. Regarding transect lines, there are 3 transect lines determined herein according to differences of the agricultural ecosystem. The first agricultural ecosystem is low plains between plains where large communities are located at. There are also good economic systems and infrastructures and the complicated irrigation system has been developed. This is favorable for doing intensive farming. The second agricultural ecosystem is agricultural areas based on rain water on slopes, which is the main problem of the region. The impact occurring at the point of collecting samples (On-site) and the impact occurring at the adjacent (Off-site) will be studied. The third agricultural ecosystem is the high land where there are development projects in several forms originating from the problem of national security. This makes them receive budget contributions for continual development for a long period of time. This type of agricultural ecosystem is different from the first 2 systems

in terms of weather atmosphere, crop elements, land use conditions and farmers who are ethnic groups which have their own particular cultures.

3. The physical and biological study consist of following procedures: Determine the survey point on the transect line; Mark the location with GPS; Drill the soil in order to study physical and chemical soil properties. Study land characteristics consisting of topography, land use restrictions, crop conditions, characteristics of land degradation and remedy measures (if available).

4. Studying the economic and social state of the community using the land near the transect line by conducting focus group interviews and interviewing individual farmers.

General information of the study area

Physical characteristics

The study area covering the upper northern region of 8 provinces located at between17°-20°30" North latitude and 97°30' East longitude-101°21' East longitude has been determined. Most of the landscape consist of mountain ranges. There are mountains adjacent to each other along North-South alternating with low plains between valleys with rivers flowing past and where there are large urban areas. The important mountain range is The Daen Lao Range which is in the north separating the border between Thailand and Burma. It is also the origin of Ping. There are Thanon Thong Chai Range and part of Tenasserim Hills in the west. There is Phi Pan Nam Range in the middle of the region. It is the origin of Wang River and Yom River. In the east, there is Luang Prabang Range, which is the origin of Nan River. The highest peak in Thailand is Doi Inthanon in Jom Thong Range of the district of Chiang Mai province. It lies above the sea level at the medium level of about 2,565 meters. Most of the topography consists of high mountains.

The area has tropical savanna climate (Aw) with the average amount of rain water accounting for 1,200 millimeters annually. The number of days with rainfall accounts for 123 days annually on average. The average temperature in winter is 23.4 °C, in summer for 28.1 °C and in the rainy season for 27.3 °C.

The soil likely to be found in the low land in valleys is soil with rough textures found in the area at the river levee. There is clay or sandy loam in the plain all the way to the highland area where there are clay and gravelly soil. It is likely to find shallow soil in the area closer to the mountain. On high mountains, soil with several characteristics can be found, including red clay.

Characteristics of natural vegetation consist of:

1. Deciduous forest is the ecosystem consisting of trees shedding their old leaves during the dry season so that new leaves can grow in the rainy season. The

exception is for plants at the lower level. They do not shed their leaves. They are found at the altitude not more than 800 meters above the sea level.

2. Tropical evergreen forest is the forest where monsoons pass almost throughout the year. For the study area at the altitude not more than 800 meters, the forest is classified into Dry Evergreen Forest. For higher altitude with high peaks, the forest is classified into Hill Evergreen Forest.

3. For coniferous forests, classifying this type of forests is mainly based on the population of vegetation types whereby the leading outstanding tree is in the pin tree family-either Pinus merkusli or Kesiya pine found in the area at the altitude more than 800 meters like Hill Evergreen Forest.

Economic and Social Characteristics

The administration of upper northern region is divided into 8 provinces whereby Ministry of Interior has combined western provinces consisting of Mae Hong Son, Chiang Mai, Lampoon and Lam Pang as Group 1 of upper northern provinces and eastern provinces consisting of Chiang Rai, Prae, Nan and Payao as Group 2 of upper northern provinces. Although in an overall picture of the 8 provinces, there are plains suitable for conducting farming with the ratio of only 15%, there are natural resources, topography and climate suitable for tourism, which can attract tourists to come for relaxation and stay occasionally and permanently. This has made the service business of hotels, resorts and souvenir sales become the main economic branch. In the economic sector, main economic crops are longan, lychee, garlic, virginia and burley tobacco leaves, shallots and onions. In an overall picture of the country, almost all of these plants are produced in the North. Moreover, there are subordinate economic crops such as rice, sugar cane, corn and soybean with the amount of yields accounting for one fourth of all national yields.

Group 1 of upper northern provinces has determined the development strategy as follows:

1. Developing the industry of tourism and services;
2. Increasing the potential of trade, investment and border trade;
3. Developing organic agriculture, safe agriculture, process agriculture creating high added values;
4. Conserving and restoring natural resources and the environment

Group 2 of upper northern provinces has determined the development strategy as follows;

1. Developing trade, investment and logistics connecting to other countries internationally;
2. Strengthening agricultural sectors, industrial sectors to increase values;
3. Developing and promoting ecotourism, cultural tourism and health tourism;
4. Maintaining the base of fertile natural resources and good environmental management

ดังกล่าว In an overall picture of the strategy of the 8 provinces, it can be seen that apart from the fact that the industry of tourism and services, which is the main income of the region, is focused, agricultural production together with the conservation of natural resources and the environment reflecting the awareness of the degradation of natural resources and land base is also focused, including having the vision to solve the mentioned problems.

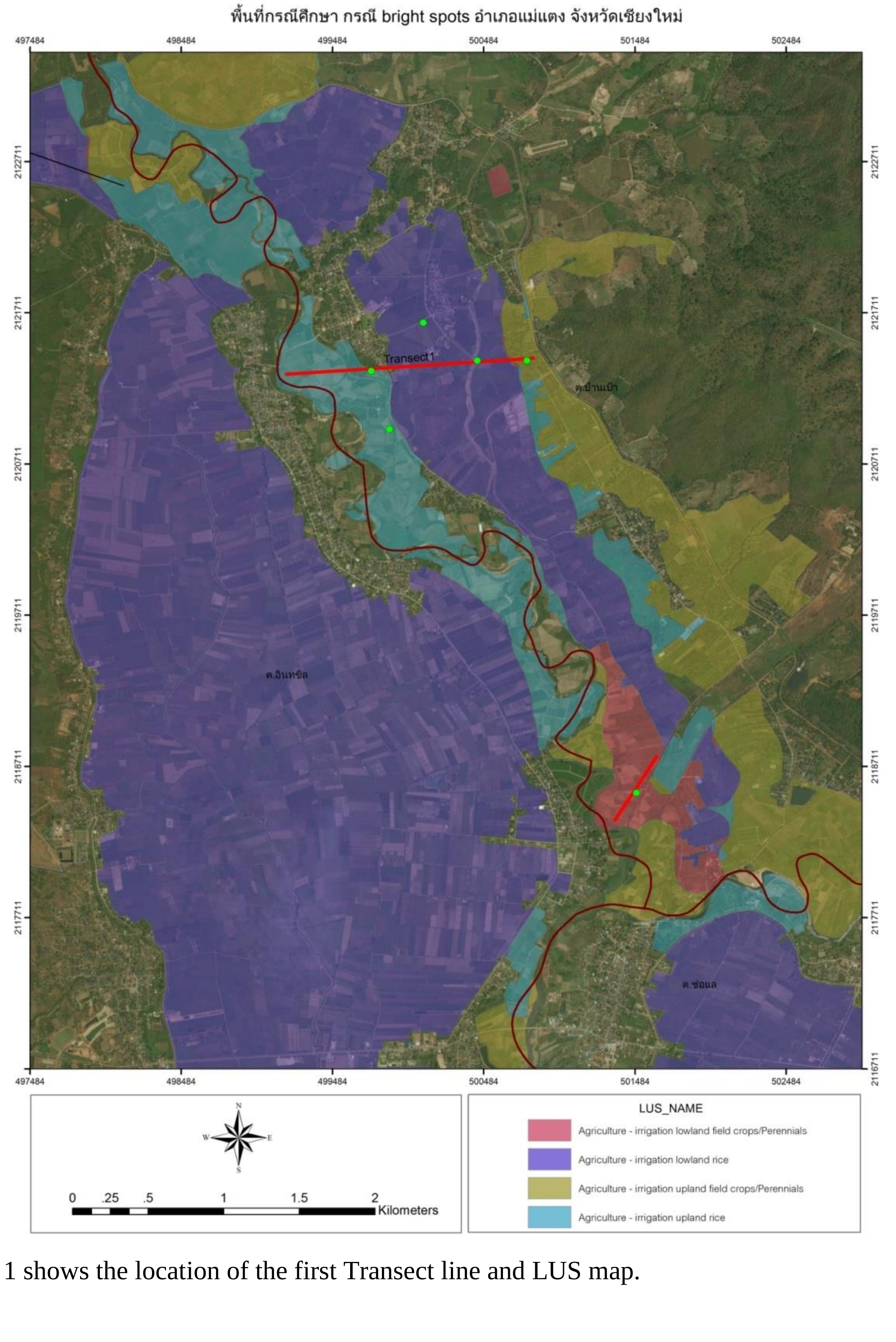
Transect lines

As mentioned, in the study, 3 transect lines have been determined to represent land use and the 3 forms of the agricultural ecosystem with the following details:

The first transect line

The study was conducted in Mae Tang district of Chiang Mai province whereby this area represents the plain in the valley. This area is suitable for conducting farming in the region because the soil is fertile and there is systematic water resource management. The government sector has invested in infrastructures and given an opportunity for farmers to participate in water management. This brings about intensive and ongoing land use throughout the year due to the fact that cities with large-scale and complicated economic structures are located at most of the plains. As a result, farmers have an opportunity to access the marketing system easily and to seek incomes out of the agricultural sector with the significant ratio. The agricultural production system aims at production for trade mainly. The main problem in terms of land degradation is the community expansion invading into areas with high agricultural potentials.

LUS appearing in this Transect line consists of Irrigation low land field crop, Irrigation low land rice, Irrigation upland field crop, Irrigation upland rice.



Picture 1 shows the location of the first Transect line and LUS map.

Picture 2 shows land use conditions in the first Transect line.

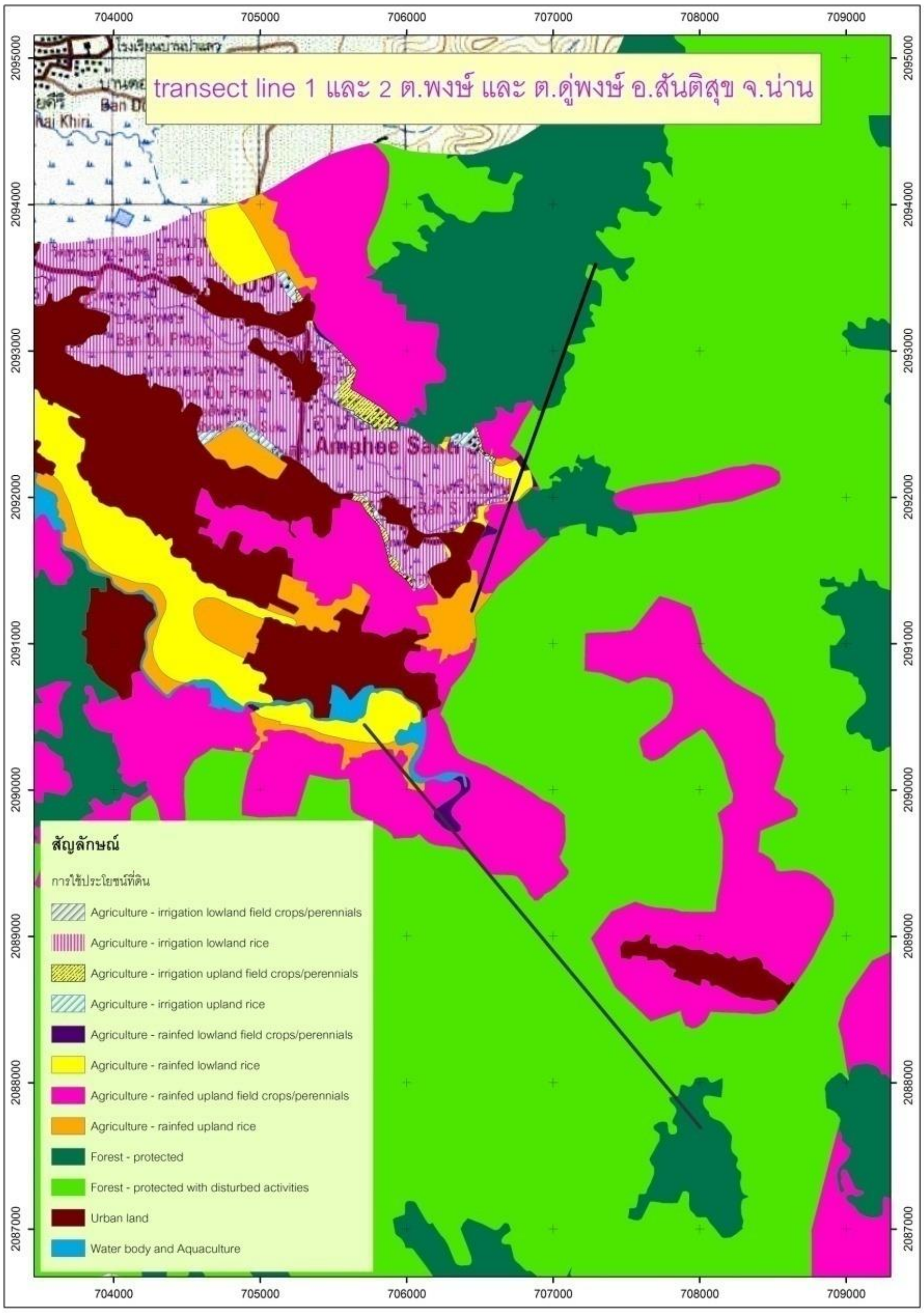
Picture 3 shows land use conditions in the first Transect line.

The second transect line

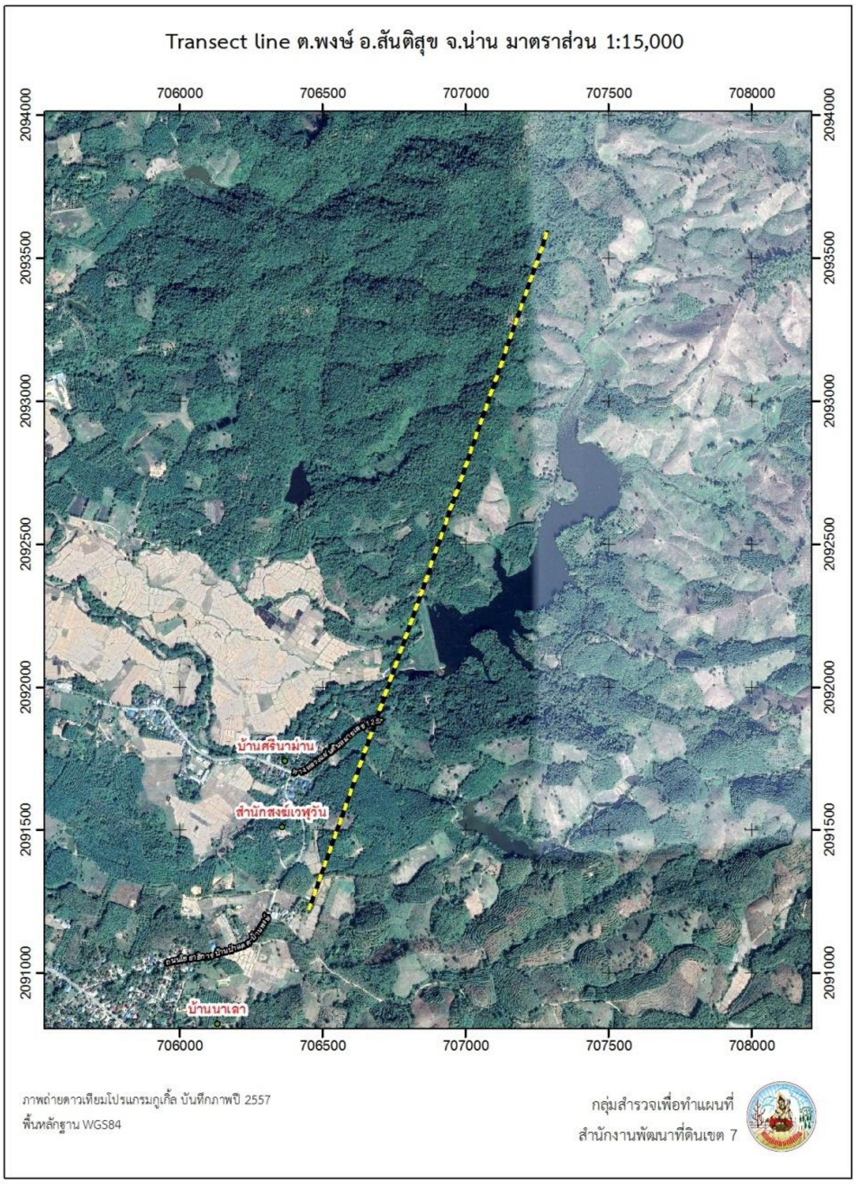
The study was conducted at Sri Boon Ruang Village, Pong Village and Sri Na Man Village of Pong sub-district, Santisuk district, Nan province. The area consists of lowlands in the small valley surrounded by steep mountains. With the limitation of the size of the plains and population pressure, farmers have expanded agricultural areas to steep mountains. From primary data, it was found that most of the forest areas had been damaged and had been changed to grow single crops (monoculture) such as corn or para rubber. The economic system of the community is small. Farmers produce rice by themselves for consumption. Important economic crops are corn and para rubber. In the lowland. there are 1 medium-sized reservoir (Pong Reservoir), 1 small reservoir and 1 diversion dam. They are utilized for irrigation. The three water resources and agricultural areas in the lowland are directly affected by the land use on mountain areas in the form of sediments piling up and damages caused by flash flood and the outbreak of mountain torrents.

This area represents land use with wrong capacities in the upper northern area by using the area of steep slopes to grow field crops and perennial plants based on rain water. In the traditional system, land use like this is conducted in the form of rotational plantation. giving natural vegetation an opportunity to bring about the ecosystem which can build ground to replace the ground lost in the erosion process during field crop cultivation. This makes sustainability at a certain degree. However, the mentioned area is in the zone of National Reserved Forest or National parks and reserves whereby according to the law, farmers are not allowed to use the land for agriculture. Due to the fact that the government sector cannot provide areas to support farmers or making a living outside the conserved zone, it limits the zone of land use and does not give farmers an opportunity to rotate land use based on the traditional system. The fact that agricultural areas lose ground and nutrients at a high rate and the soil structure is damaged, productivity of the soil has been decreased. Moreover, the reduced forest areas in the upriver zone has caused the loss of important ecological services such as control of the water-giving state of watercourses also flowing past the lowland.

LUS appearing in this transect line: Irrigation low land rice; rainfed low land field crop; rainfed upland rice; rainfed upland field crop / perennial; disturbed forest; protected forest



Picture 4 shows location of the second transect line and LUS map.



Picture 5 shows land use conditions in the second transect line from the satellite map

Picture 6 shows land use conditions in the second Transect line in LUS as disturbed forests.

Picture 7 shows sediments piling up in front of the spillway of Nam Pong Reservoir.

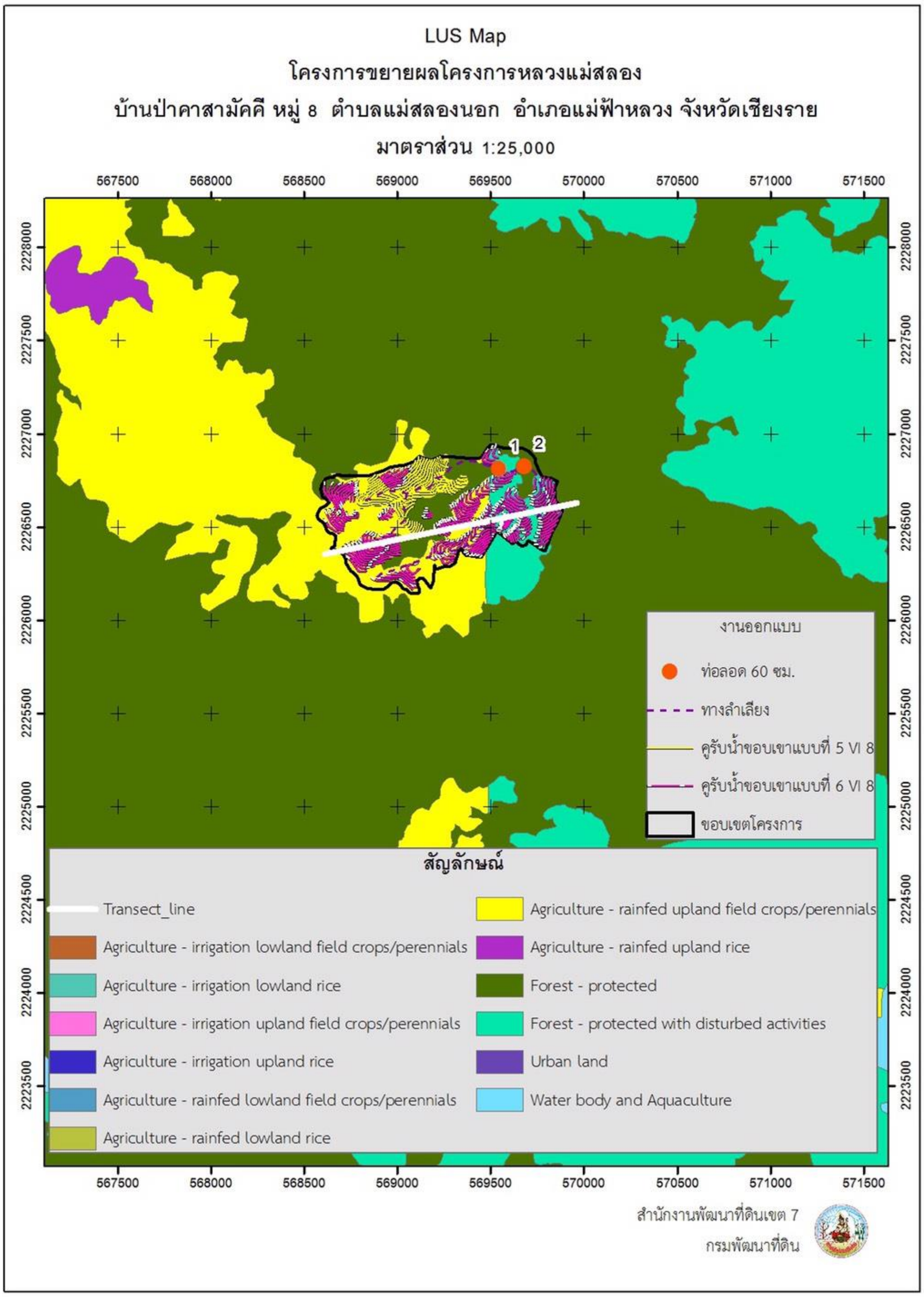
The third transect line

The study was conducted at the highland development project of Mae Salong Royal Project, Mae Salong Nok sub-district, Mae Fah Luang district, Chiang Rai district. In general, the topography consists of steep slopes of mountainous areas. There is conserved forest encroachment to do farming based on rainwater whereby the problem lies in the fact that land use limitation is controlled like in the second transect line. Regarding the structure of farming, there are characteristics of the integration between commercial production and subsistence production whereby farmers still focus on field rice cultivation for food security. At the same time, they are interested in finding alternative crops which can create more incomes. The alternative crops which farmers are interested in growing tend to be fruit trees or perennial plants which can give out yields well in the highland such as Chinese plum, lychee and coffee etc.

Originally, the Thai government arranged this area as the shelter of Chinese soldiers of the Republic of China Army's 93rd Division on order to use this troop as a buffer against the unrest along the border at the time when there was fighting between the communist party and the Thai government. Later after the fighting was over, this troop agreed to disarm and turned to do farming as a profession instead under the support of the supreme Command Headquarters in the form of the area development project for security. Besides Chinese immigrants, there are also other ethnic groups residing in the area.

At the study point, Land Development Department has arranged the system of conserving soil and water as a hillside ditch along with promoting the cultivation of fruit trees and perennial plants in order to use the land according to capacities.

LUS appearing in this transect line: rainfed upland field crop/perennial; disturbed forest and protected forest.



Picture 8 shows the location of the third transect line and LUS map

Picture 9 shows the overall land use of the third transect line.

Results of overall operation

1. Having finished collecting physical data in the area and conducting Focus group interview in the first and second transect lines. Data processing is being conducted.
2. The third transect line will be conducted during the third week of March.
3. Collecting soil samples to send them to be analyzed to the soil analysis group of Land Development Regional Office 10 is still in the process

Picture 10 shows the soil and water conservation measure in the form of a hillside ditch at the mountain ridge and fruit tree cultivation

Progress report
Assessment of the degradation of natural resources related to local land use
Acid soil working group

1. **Team of operators**

Expert Kunwadee Sutthawat is the leader of the team + teams of Land Development Regional Office 1, 10, 11 and 12

2. **Results of overall operation**

2.1 Holding a meeting of the working group to select areas has already been conducted

2.2 Selecting the operation area from the map data of nationsl land degradation (QM) gave out 2 areas

with the following details:

2.2.1 Bright spot represents agricultural areas in the lowland. It is the rain water agricultural area. Some areas has the irrigation system. Soil originated from river sediments piling up on marine sediments and brackish water sediments. The degradation of soil resources is the soil acid problem. Most areas have been improved and there are demonstration plots of acid sulfate soil improvement in the Royal Idea Project. Selecting the area for survey is divided into 3 Transects, namely

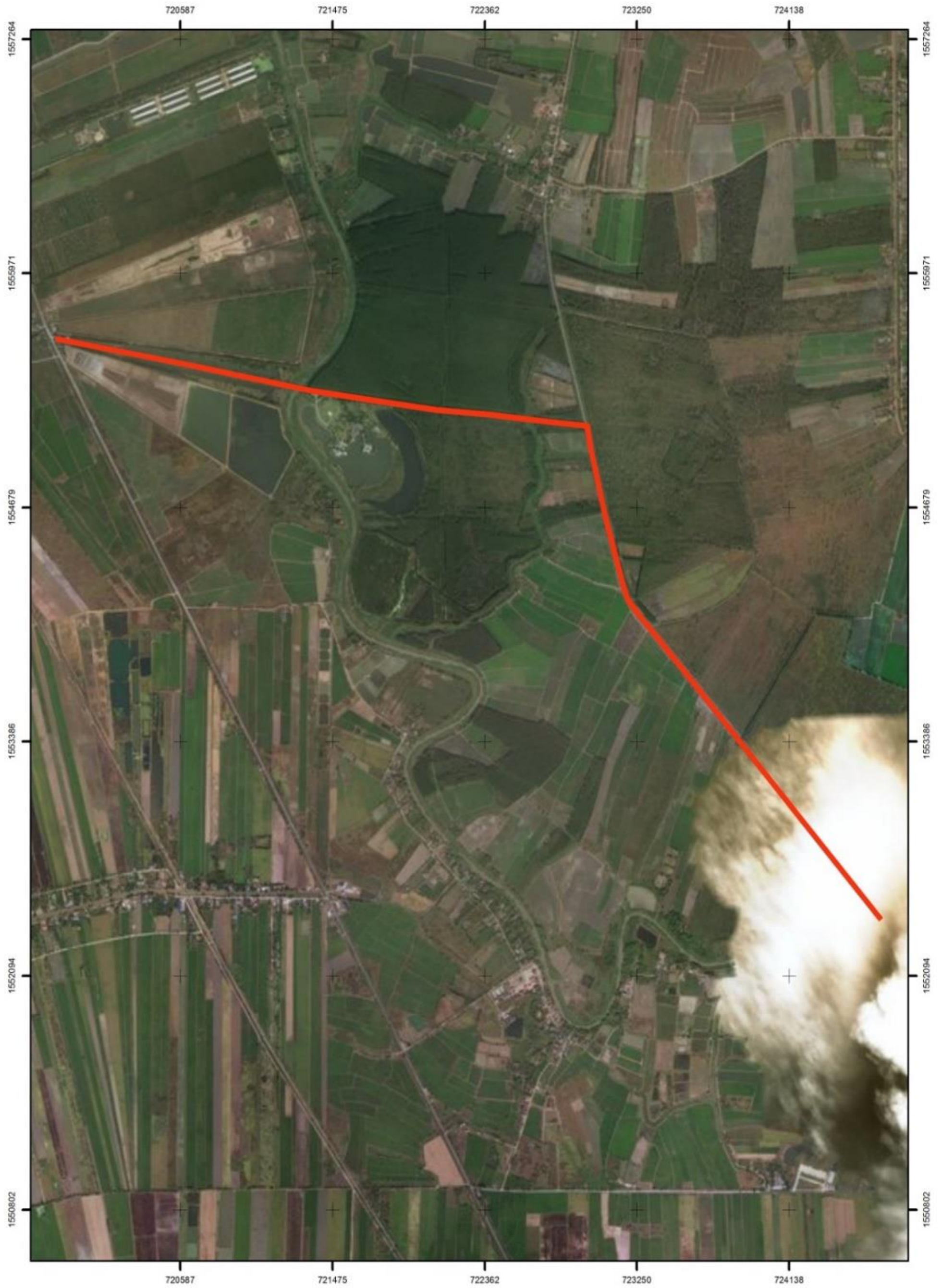
Transect 1 ตำบลบ้านพริก อำเภอบ้านนา จังหวัดนครนายก

Transect 1: Ban Prig Sub District, Ban Na District, Nakhon Nayok Province

Transect 2 ตำบลเกาะหวาย อำเภอปากพลี จังหวัดนครนายก

Transect 2: Koh Wai Sub District, Pak Plee District, Nakhon Nayok Province

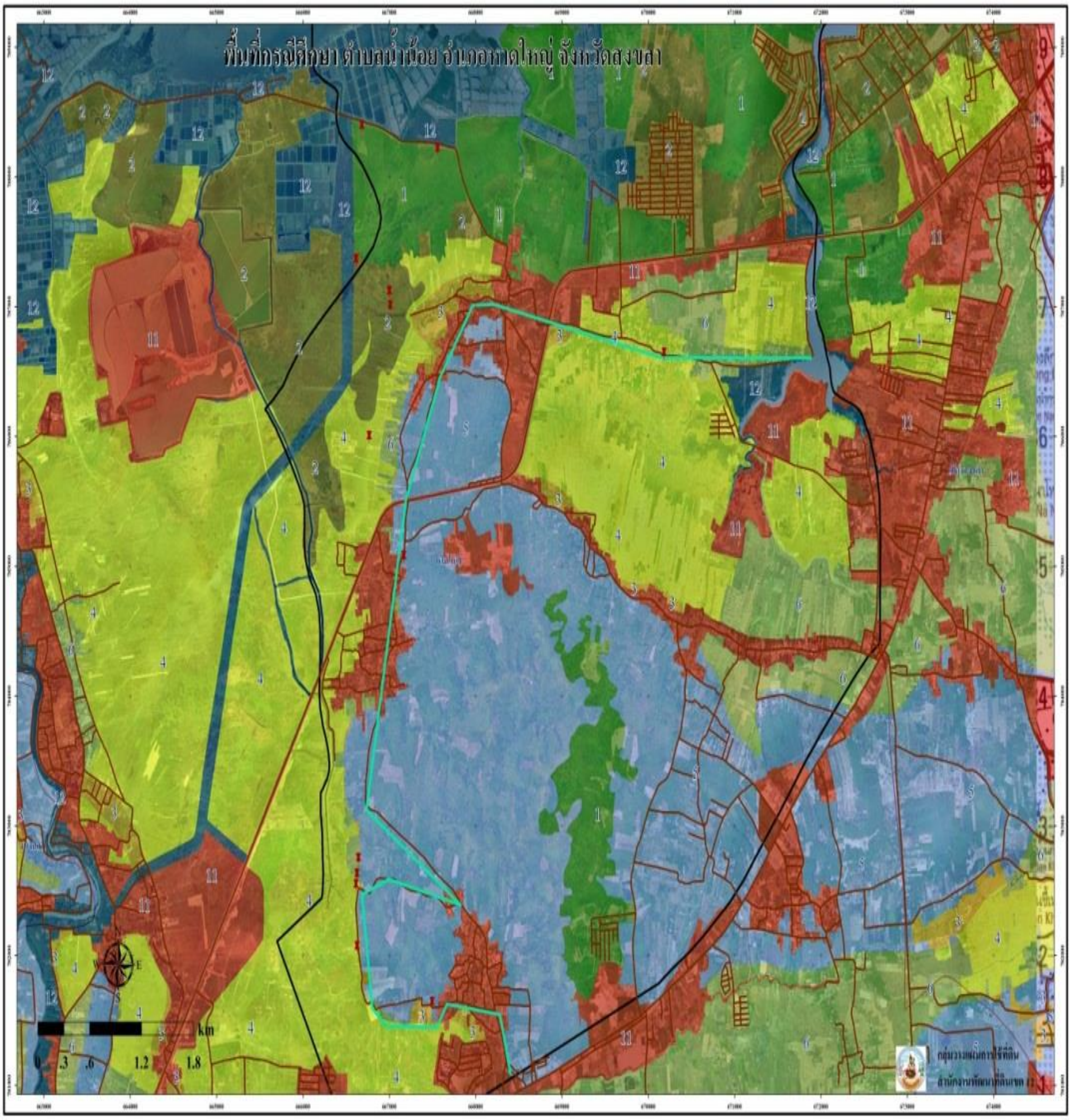
Transect 3 ตำบลบางลูกเสือ อำเภอองครักษ์ จังหวัดนครนายก



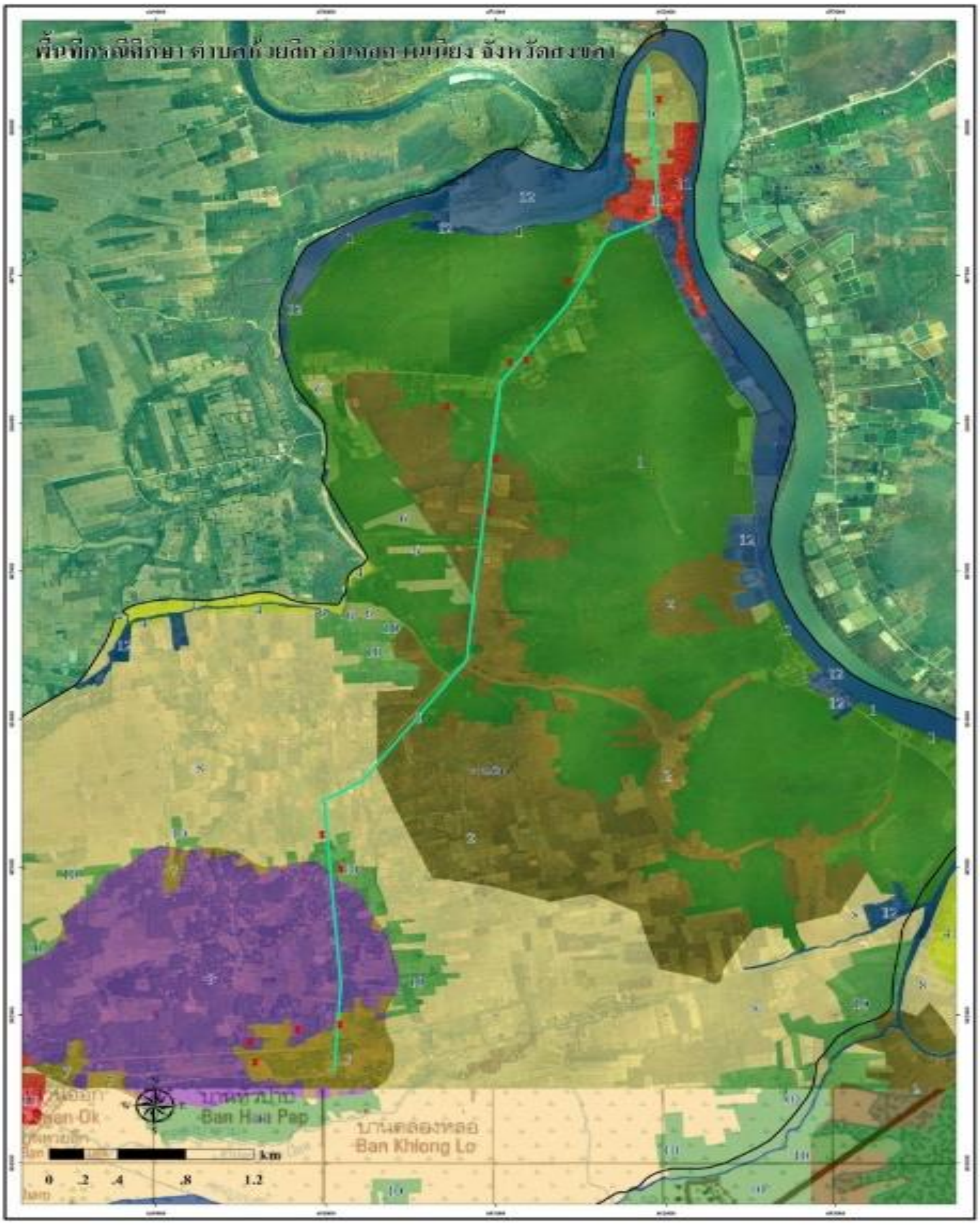
Transect 3: Bang Luk Sueh Sub District, Onkarak District, Nakhon Nayok Province

2.2.2 Hot spot represents agricultural areas in the lowland. It is near the sea. Upheld by sea water in the rainy season, it is flooded with water-logging conditions every year. The degradation of soil resources is the acid soil problem and most of the areas have not been improved.

Selecting areas for survey is divided into 2 Transects, namely

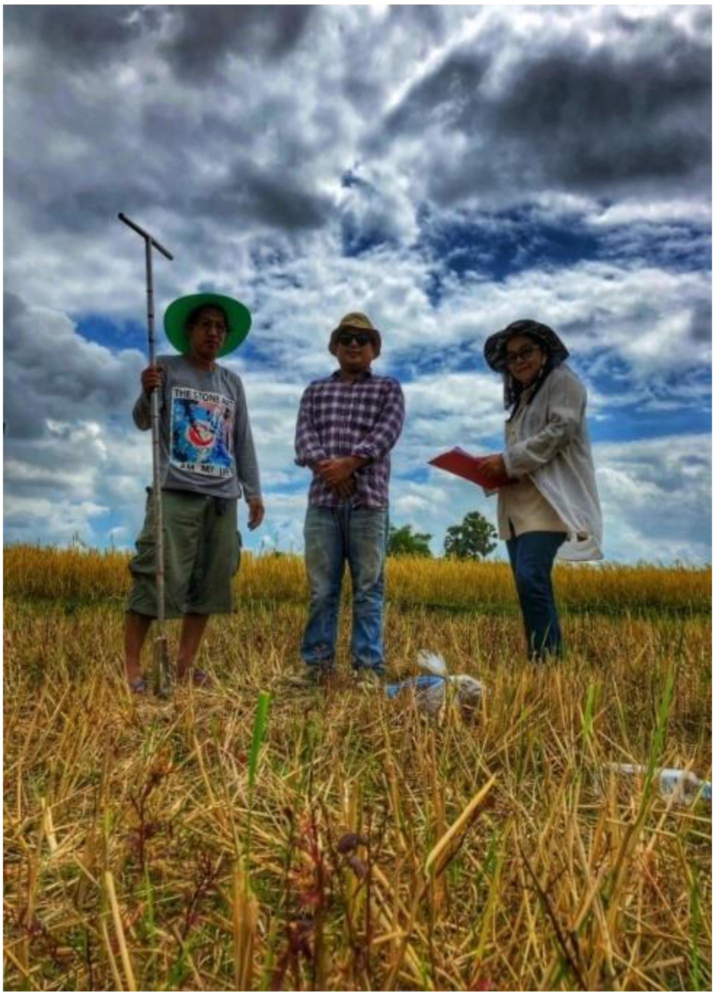


1. Nam Oy sub-district, Hat Yai district, Song Khla province



2. Huay Luek sub-district, Kwon Niang district, Song Khla province

2.3 Soil and natural resources survey according to LUS found in the area and soil sampling have already been conducted for the 2 areas, accounting for the total of 5 transections.



48


cm
10
30
50
70


C 4/1

2.4 Livelihood Assessment survey and Focus group interview of the 2 areas have already been conducted.

3 Activities which are in the process of operation:

3.1 Data collection and data analysis from interviewing farmers and conducting Focus Group;

3.2 Analyzing soil to find nutrients and elements used in soil resource assessment;

3.3 Analyzing the data of assessing natural vegetation and soil data in the field;

3.4 Preparing other related data to prepare the report

Report on 11 March 2018
Kunwadee Sutthawat

Progress report of
assessing natural resource degradation related to local land use
The working group of areas with saline soil

1. **Operation group**

List of the working group of Local Land Degradation Assessment, Land Development Regional Office 5

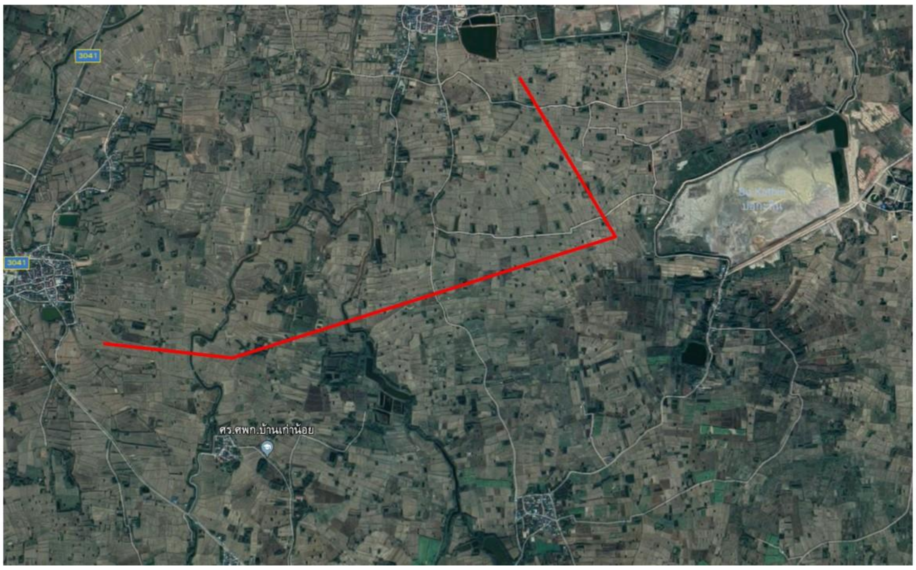
1. Mrs. Pranee Seehabun, Expert of laying out the land development system, Land Development Regional Office 5
2. Mrs. Pornpana Pothinam, Director of Technical Group for Land Development, Land Development Regional Office 5
3. Mr. Jakkrapun Paosrakoo, Director of Technical Groups for Land Development, Land Development Regional Office 3
4. Mrs. Usa Jakkraraj, Agricultural Technician, Specialst, Land Development Regional Office 5
5. Mrs. Supranee Sritamboon, Agricultural Technician, Specialist, Land Development Regional Office 5
6. Mr. Veerapong Roepundung, Agricultural Technician, Specialist, Land Development Regional Office 5
7. Miss Sudsanguan Thiemthaisong, Agricultural Technician, Specialist, Land Development Regional Office 5
8. Mrs. Pattaranit Chuaysranoi, Agricultural Technician, Specialist, Land Development Regional Office 3
9. Miss Kaewchai Orchaiyaphum, Agricultural Technician, Professional Level, Land Development Regional Office 3
10. Miss Kanokwan Harnsukchaicharoen, Soil Surveyer, Professional Level, Land Development Regional Office 4
11. Mr. Rattana Sutakham, Operation Economist, Land Development Regional Office 4

2. **Results of operation**

2.1 Holding a meeting of the working group to select areas has already been conducted.

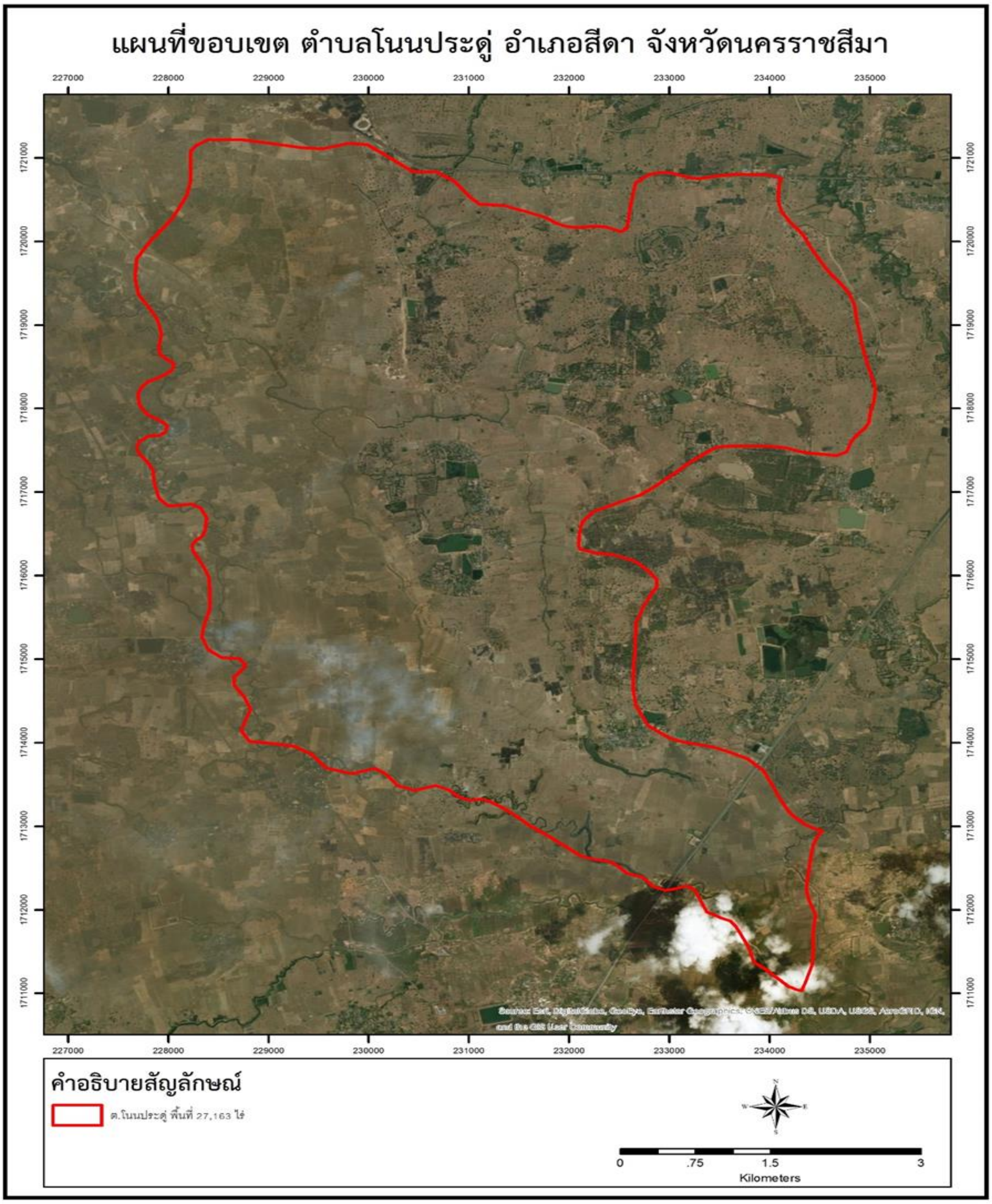
2.2 Selecting the operation area from the national land degradation map (QM) gave out 2 areas
with the following details:

2.2.1 Bright spot represents agricultural areas in areas with saline soil and most of the areas have been improved in the plain. Farmers utilize the land for rice cultivation. Selecting areas to survey the Transect in the area of Ban Phai district, Khon Kaen province.



2.2.2 Hot spot -Selecting the area of Non Pradu sub-district, Sida district of Nakhon Ratchasima province to represent agricultural areas in the highland and the plain, in the area based on rain water. The degradation of soil resources are the saline soil problem and inappropriate land use. From the data of asking community leaders and farmers for information, it was found out that regarding having done farming for the past 10 years, there were inappropriate land use as follows: 1) There was utilization on the highland to grow rice in 2011 due to the high price of rice; 2) There was soil drilling in areas with saline soil to build roads connecting villages; 3) Burning stubbles; and 4) Increasing the amount of chemical fertilizer use every year and 5) Climatic changes. The mentioned problems have caused the degradation of soil, water, forests and the environment. Findings also revealed that there was dispersion of saline soil in the plain used for rice cultivation increasingly. currently, there is land use as follows: 1) The highland used for rice cultivation accounts for 30%; 2) The plain used for rice cultivation accounts for 70%.

The selection of areas for survey for 1 Transect is Non Pradu sub-district, Sida district, Nakhon Ratchasima province whereby livelihood assessment survey and Focus Group have already been conducted.



Non Pradu sub-district, Sida district, Nakhon Ratchasima province

Pictures of conducting the livelihood assessment survey and Focus Group in the Hot spot area

2.3 For the Bright Spot area, conducting the survey of soil and natural resources according to LUS found in the area and soil sampling




Conducting the survey of soil and natural resources found in the Bright Spot area according to LUS

3. Activities which are in motion

3.1 Surveying Livelihood Assessment and Focus Group are scheduled to be finished within ... April 2019.

3.2 Conducting the survey of soil and natural resources according to LUS found in the area and soil sampling in the hot spot area is scheduled to be finished within 28 March 2019.

3.3 Collecting data and analyzing the data from interviewing farmers and conducting Focus Group

3.4 Analyzing soil to find nutrients and elements used to assess soil resources

3.5 Analyzing the data of assessing natural vegetation and the data of soil in the field

3.6 Preparing other related data in order to prepare the report

Module 5 SLM Territorial Planning

- **40 Technologies and Approaches**
- **Demonstration Site**

1. Name of Project: **Acid Sulfate Soil Management for Rice cultivation**

2. Responsible people consist of:

2.1 Consultants

Miss Bunjirtluk Jintaridth, acting Expert on acid soil improvement

2.2 Head of the project

1) Miss Ratikorn Na Lampang, Agriculture Technical Officer, Senior Professional Level

2) Miss Mantana Suriyawongpongsa, Agriculture Technical Officer, Senior Professional Level

3. Operation site

Ko Wai sub-district, Pak Pli district, Nakhon Nayok province

Coordinates: In UTM System, 47Q is 47P 0743384E 1565784N

Rangsit soil series, Soil series 11

4. Procedures

1) (LR) Scattering marl according to lime requirement (LR) of the soil

2) Grow rice of Gor.Kor. 49 variety based on wet broadcasting paddy field

3) Using chemical fertilizers according to the value of soil analysis by calculating from the tailor-made fertilizer program

For the first time after sowing- the rice has germinated for 20days

- 46-0-0 fertilizer for the amount of 10 1 kilograms per rai
- 18-46-0 fertilizer for the amount of 110 kilograms per rai
- 0-0-60 fertilizer for the amount of 70 kilograms per rai

For the second time, making up during rice pregnancy of 60-65 days after sowing

- 46-0-0 fertilizer for the amount of 50 kilograms per rai

4) Adding fermented bio-extracts from catalyst LDD.2

For the first time, adding fermented bio-extracts for the amount of 50 liters at the period of soil preparation

For the second time, adding fermented bio-extracts for the amount of 50 liters when the rice tree is at the age of 30 days together with letting water flow into the paddy field

For the third time, adding fermented bio-extracts for the amount of 50 liters when the rice tree is at the age of 50 days together with letting water flow into the paddy field at the same time

For the fourth time, adding fermented bio-extracts for the amount of 50 liters when the rice tree is at the age of 60-65 days together with letting water flow into the paddy field

5) Weed eradication

There is weed eradication both in the paddy field and on the ridge

6) Water management in the plot

- Controlling water level for the first seven days after sowing so that the water level almost floods the rice tree

- When the rice starts being pregnant, the water is drained from the paddy so that the water remains at the mixed firewood level (5-7 centimeters).

5. Plot diagram

Demonstration plot
Farmers' methods

6. Reporting results of operation with digital pictures, collecting pictures with caption, highlighting under pictures

FAO officers visit demonstration plots.

Rice at the age of 100 days

Measuring the height of rice trees randomly

Collecting data of elements of yields, the number of ears of rice

Rice at the age of 110 days

1. Project Title: Planting Perennial Eucalyptus on the rice bunds to Mitigate Saline Soil and Development of Salinity Affected Areas in the Northeast of Thailand, Khon Kaen Province (Demonstration site)

2. Objectives

The proposed project has the following objectives:

1. To study and collect basic chemical and physical properties data soil in the area that promotes eucalyptus cultivation on the rice bunds in saline soil,
2. To organizing meetings, transferring and extending the technology of growing eucalyptus on the rice bunds to reduce saline soil spread and assess private return of the proposed intervention including its effect on social-ecological resilience of households to shocks,
3. To assess environmental benefit of the proposed intervention and estimate its social rate of return,
4. To provide evidence for informed decision making to ensure favorable effects of the intervention on agriculture production, environment and quality of life of farmers.

3. Time Frame and Schedule

The length of the proposed project is 8 months (December 2018 – June 2019).

4. Project Site

The project covers the following areas:

- Pueai Yai Sub-district,
- Non Dang Sub-district,
- Mueang Phon Sub-district and
- Nong Pla Mo Sub-district,

All are under the Non Sila District of Khon Kean Province.

5. Scope of the Project

The proposed research project focuses on evaluating effectiveness of salinity mitigation effect of growing eucalyptus trees on rice bunds. The selection of rice is justified by its important role as the key economic crop in the region. The study examines economic returns of eucalyptus and assess its environmental effects.

6. Activity and Work Plan

Fiscal Year	Activity	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
2018	**Site selection and collect basic information**	x	x								
2018	**Collect soil and plant samples, conduct an analysis of soil's physical and chemical properties and measure soil salinity**			x	x	x	x				
2018	**Site preparation for eucalyptus planting, modify rice field bunds, procure eucalyptus seedlings**				x	x	x	x			
2019	**Collect post experiment samples of plant and soil**					x	x	x			
2018-19	**Field day to educate farmers and promote adoption of technology**					X	X	X			

Fiscal Year	Activity	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
2018-19	**Collect aerial photos for a rapid assessment of eucalyptus growth in saline soil**		x	x	x	x	x	x			
2018-19	**Assess social and ecological resilience of households adopting the technology**			x	x	x	x	x			
2019	**Collect data and analyze data**								x	x	
2019	**Final report preparation and dissemination**										x

7. Operation results

7.1 Field Day

An Exhibition Meeting to explain the project in order to expand the eucalyptus on the rice bunds to enhance the well-beings of farmers in saline soil areas in the Northeast of Thailand was organized and presided over by Mr. Kornkiat Chanphungsuk, the Director of the Land Development Regional Office 5. Mr. Chettaruj Janplang, the Director of the Saline Soil Management and Development Group of the Research and Development for Land Management Division, provided a report to the chairman in the meeting on 27-28 March and 2-3 April 2019. A total number of 530 farmers participated in the field day activities. The field day was structured to have two main activities, i.e. awareness raising through exhibition and expert lectures. The exhibition is an activity under the Decision Support for the Mainstreaming and Scaling out of Sustainable Land Management (DS-SLM).

Figure 1 : Mr. Kornkiat Chanphungsuk, the Director of the Land Development Regional Office 5, Presided over the Field Day's Opening Ceremony

1. An Awareness Raising and Knowledge Exhibition.

1.1. The exhibition provided information and knowledge on how soil salinity occurs and mechanisms in which soil salinity spreads in the northeastern of Thailand and how growing eucalyptus on rice bunds help to mitigate the salinity. The activity was led by the Saline Soil Management and Area Development Group of the Research and Development for Land Management Division in cooperation with the Land Development Regional Office 5 whose goal is to support and promote farmers and land users in the salinity affected areas to have a better quality of life by using appropriate technology to solve the problems and to control the spread of soil salinity in agricultural areas. The introduction of the eucalyptus cultivation, an economic perennial plant that can grow in saline soil areas, serves to achieve these objectives. Knowledge products used in the exhibition are shown in figure 1-4 including backdrop, posters, brochure

Figure 2 : The Backdrop Providing Knowledge of Soil Salinity and Benefits of Planting Eucalyptus on the rice bunds.

Figure 3 : A Brief Introduction to the Demonstration Activity of the DS-SLM Project

Figure 4 : Brochure on the Planting Eucalyptus on the rice bunds for the Development of the Saline Soil Areas in the Northeast of Thailand

1.2 *Knowledge of Soil Analysis*. The Land Development Regional Office 5 trained farmers on how to conduct soil analysis and its benefits. The farmers were given opportunities to bring their own soil from their fields for an analysis of their chemical and physical properties. The purpose of these analyses is to provide information on how farmers can improve their soil fertility to enhance crop productivity benefit at minimum costs.

1.3 *Knowledge Dissemination on Economic Benefits of Planting Eucalyptus* in salinity affected areas and marketing opportunities of the Eucalyptus. The Siam Forest Co., Ltd, a leading company in eucalyptus plantation, provided market and technical advice to farmers.

2. Special Lectures by Soil Salinity Experts

Ms. Rosalud de la Rosa, an FAO consultant, and Dr. Bunjirtluk Jintaridth, a Specialist on Acid Soil Improvement and DS-SLM Project Focal Point, offered greeting messages to farmers and participants on behalf of the FAO's DS-SLM Project. The government's general commitment toward improving living standards of farmers was highlighted and LDD's readiness to support the development and solutions to land degradation problems in agricultural areas. A session of special lectures was followed.

Figure 5 : Ms. Rosalud de la Rosa, a representative of FAO, Delivered a Greeting Message to Farmers and Participants on Behalf of the Mainstreaming SLM Project

2.1 *Project Background and Overview*. Mr.Chettaruj Janplang, the Director of the Saline Soil Management and Development Group of the Research and Development for Land Management Division, discussed the genesis and history of Planting Eucalyptus on the rice bunds for the development of the saline soil area in the Northeast of Thailand. Objectives of the project activities were explained. Ones of which were to assess soil and environmental changes in the area where Eucalyptus is grown and to encourage farmers to grow Eucalyptus on the rice bunds to prevent the spread of saline soil in agricultural areas. The study will also assess the extent of benefits from greater utilization of land and socio-economic benefits from domestic and commercial uses of Eucalyptus.

2.2 *Saline Soil Management in the Northeast of Thailand*. Ms. Pranee Sihaban, a land development system specialist of the Land Development Regional Office 5, explained how soil salinity is formed and the mechanisms in which soil salinity occurred and spread in the Northeast of Thailand. Soils that have a large amount of salt solution in them could affect crop growths and yields. Key guidelines and solutions for saline soil are washing away salinity using water, adding organic matter to maintain soil fertility, and cultivation of salt tolerant crops or salt resistant perennials plants that are suitable to different levels of soil salinity.

2.3 *Reshaping Rice Fields and Plots for the Development of Agricultural Land in Salinity Affected Areas*. Mr. Weera Ropandung, a soil scientist expert, provided a lecture on how reshaping field plots in ways that suited the topographical conditions and crop types can improve efficiency of land use.

2.4 *The Use of LDD's Developed Technology for Soil Fertility Improvement and Saline Soil Management in the Rice Field Areas*. Ms. Sudsagnuan Thiamthaisong, a soil scientist expert, made a presentatio on how different level of soil salinity ranging from mildly, moderately and highly saline, can be mitigated and its fertility can be improved using various types of microorganism accelerator products such as LDD1, LDD2, LDD7, LDD11 and LDD12. The given knowledge is simple and highly practical for farmers to easily apply in their fields and to share with their neighboring farmers and others in the future.

Solving soil salinity using fast growing perennials such as eucalyptus which can be grown in a wide variety of environment in the northeast where the farming areas are in the plateau is not only an effective method to control the spread of soil salinity but also an extra household income source that requires minimum efforts. The eucalyptus can be planted in many ways, for example:

Planting one row of eucalyptus on existing and relatively narrow rice bunds that are 60-70 centimeters wide and about 50-60 centimeters high. The eucalyptus can be planted for 1 row with a distance between 1-2 meters. The planting hole with a dimension of about 50x50x50 centimeters (width x length x depth).

Figure 6 : Planting 1 Row Eucalyptus on the rice bunds

Planting on a modified ridge with a width of 150 centimeters and a height of 60 centimeters. Eucalyptus can be planted in 2 rows in a zigzag pattern. A growing distance between rows is 1 meter and each tree is grown 1.5 meters apart. In one rai of a rice filed, approximately 80 trees can be grown. The planting hole should be of the size of 30x30x30 cm (in width x length x depth) due to a loose aggregation of soil.

Figure 7 : Planting 2 Rows of Eucalyptus on the rice bunds

2.5 Private Sector Involvement. The Siam Forest Company Limited (a subsidiary of Siam Cement Group (SCG), the biggest cement company in Thailand) whose main business is a pulp and paper as well as wood for furniture product, joined the field day event by providing technical and marketing knowledge to farmers on the economic and environmental benefits of growing eucalyptus on the rice bunds. In this exhibition, representatives from SCG provided knowledge on how to effectively and efficiently grow eucalyptus Including knowledge on how to prepare soil, planting methods, planting, repairing, fertilizing, caring and harvesting. The eucalyptus's soil salinity mitigation benefits were also highlighted.

Figure 8 : The Opening Ceremony and the Honorable Delegations Attending the Field Day and Exhibition of the Decision Support for Mainstreaming and Scaling out of Sustainable Land Management Program. (DS-SLM)

Figure 9 : Participating Farmers of the Field Day Activity to Promote Eucalyptus Planting on the rice bund to Reduce the Spread of Saline Soil in the Northeast of Thailand

Figure 10 : 5,000 Eucalyptus Seedlings Were Distributed to the Field Day's Participating Farmers

Figure 11 : The Soil Analysis Group of the Land Development Regional Office 5 Provided Mobile Soil Analysis Services to Participating Farmers.

Figure 12 : Farmers Participating in Special Lectures on Technologies to Mitigate Soil Salinity

Figure 13 : Siam Forest Co., Ltd. Participated in the Field Day Event by Organizing a Knowledge Booth to Educate Farmers on the Planting of Eucalyptus in the Saline Soil Area

7.2 Socio-Economic Research

A field survey at a household level was conducted on May 1-3, 2019 in several villages in Khon Kaen province. The survey instrument covers household demographic characteristics, changes in soil salinity, household production and income sources, costs and benefits of growing Eucalyptus and status of households' five capitals. The reference time frame is 10 years since Eucalyptus planting on the rice bunds in the areas has started around that time. About a hundred of randomly selected households have been interviewed. The targeted samples are rice farmer households growing Eucalyptus for 0, 2, 4, 6 and 8 years.

Prior to the interview, a training session for the enumerators was conducted in order to ensure thorough understanding of logics behind each question. The design of this study is based on the concept of quasi-social experiment by dividing farmers into three groups:

- Group I: is the traditional farmers not growing Eucalyptus trees on rice bunds,
- Group II is the traditional farmers not growing Eucalyptus trees on rice bunds but has a part of their fields connecting to that of Eucalyptus growers, and
- Group III is the Eucalyptus growers.

The first two groups are controlled groups and the third group is the experimental group. The livelihood of both groups are assessed in order to examine long-term impacts of the technology on changes in the soil salinity situation as well as on the sustainability of its long-term impact on farmers' well-beings. The difference-in-difference between the two groups is used in order to control for the unobserved effects of confounding factors. It is worth noting that ideally changes in soil salinity should be scenically measured. However, due to the lack of such data, relying on observations of farmers who spend day-in and day-out on their field for many years is the second best option to obtain such data.

Figure 14 : Interviewing Rice Farmers Growing Eucalyptus on Rice Field Bunds at a Target Study Area

7.3 Using of Aerial Images for Growth Assessment of Eucalyptus Planted on the rice Bunds in Saline Soil Area

1. Site selection

This study is selected an area of Eucalyptus planted on the rice bunds in saline soil at moderate and high levels. The degree of saline soil area is determined by using saline soil map of LDD (figure 15). There are 4 plots are slected that vary by ages of Eucalyptus including 4, 6, 8, and 10 year olds. Moreover, each plot consists of 5 sub-plots as show in table 1.

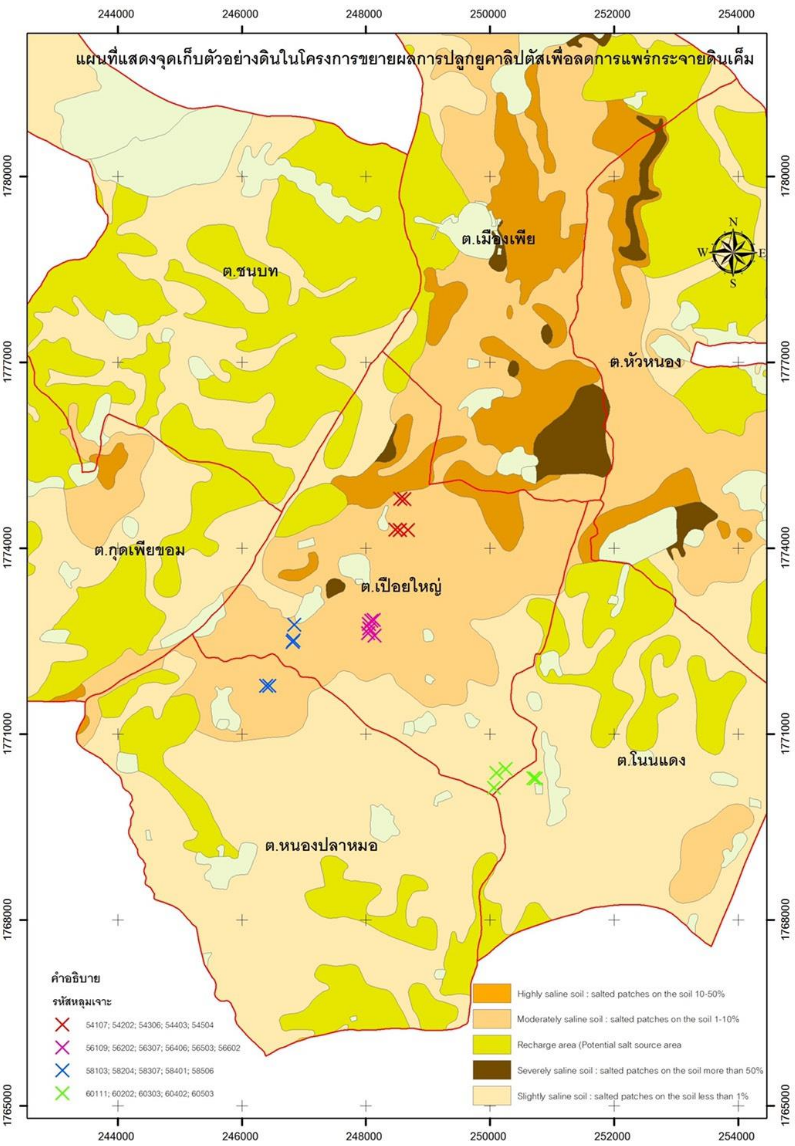


Figure 15 : The study area that is determined by using saline soil map of LDD

Table 1 : Locations of sub-plots.

Eucalyptus 10 year olds plot			Eucalyptus 8 year olds plot		
Sub-plot	**LAT**	**LON**	**Sub-plot**	**LAT**	**LON**
1	1774789	248630	1	1772627	248047
2	1774795	248563	2	1772586	248151
3	1774291	248684	3	1772704	248062
4	1774291	248554	4	1772773	248059
5	1774295	248488	5	1772829	248099
Eucalyptus 6 year olds plot			**Eucalyptus 4 year olds plot**		
Sub-plot	**LAT**	**LON**	**Sub-plot**	**LAT**	**LON**
1	1771779	246398	1	1770285	250709
2	1771775	246448	2	1770283	250746
3	1772509	246839	3	1770135	250074
4	1772484	246824	4	1770372	250113
5	1772761	246850	5	1770438	250258

2. Soil Sampling

Soil samples are collected 2 times by hand auger at 1 to15 centimeter depth from soil surface. In each sub-plot, there are 3 locations for soil sampling that is related with the locations of plant growth data collection. There are totally 60 soil samples. The soil sampling locations are marked by using GPS device. All soil samples are sent to lab of LDD regoin 5 to analyze soil pH, soil EC, soil OM, N, P, and K.

3. Plant data collection

Eucalyptus trees are measured height and girth at breast height (GBH) randomly. All trees are marked location by GPS device. There are 40-50 trees per plot (Figure 16). Plant growth data are analyzed on SPSS software.

Figure 16 : Growth of Eucalyptus planted on the rice bunds in saline soil are different ages

4. Aerial images acquisition

Aerial images are taken by multispectral cameras mounted on drone. The images are taken 2 times synchronize with soil and plant data collection. The images are calculate vegetation indices; for example, Normalized Difference Vegetation Index (NDVI), Green Normalized Difference Vegetation Index (GNDVI), etc. The images are taken from 4 locations; such as, Eucalyptus 4, 6, 8, and 10 year old plots as show in figure 17.

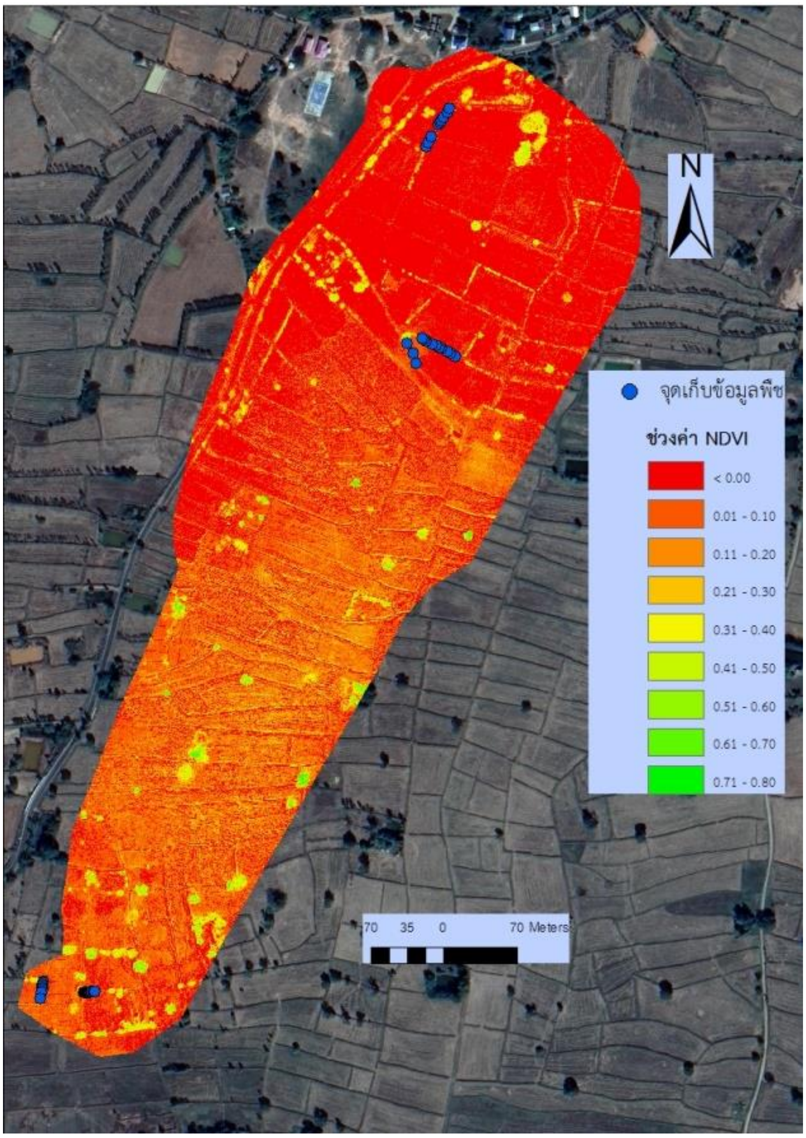


Figure 17 : Plant sample points are overlay on NDVI calculated aerial image of 4 years old Eucalyptus planted on the rice bunds

Research

1. TITLE:

Assessment of soil and plant properties by remote sensing data from UAV aerial imagery for rice cultivation in central plain of Thailand

Totsanat Rattanakaew, Apisit Boupai, Bunjirtluk Jintaridth and Pitayakon Limtong

2. RATIONAL:

Agricultural sector is a backbone of Thailand because it is the most important sector in national economy, one that has generated food and living incomes for most of the Thai people. Thailand; in addition, remains one of the largest global food exporters; especially, rice. However, the agricultural production of Thailand is still relied on traditional agricultural system which climatic factor is a major factor causing fluctuation in agricultural production. Most farmers utilize high input; for example, fertilizer, water, and insecticides; however, productivities of most economic crops have not improved in spite of the fact that growth in agriculture has been increased. The agricultural product is increased because farm land expansion and high intensive land utilization; such as, expansion of dry season cropping, in particular rice. Production increase in rice has been based on double cropping rather than increases in yield per area, not rather from used high efficiency input utilization. Rice yield in Thailand has remained virtually constant and some have shown a downward trend (FAO, 2006) although use high amount of inputs.

Agricultural production system on a sustainable basis is one of the most critical challenges for the future of humanity because the world population is projected to reach 9.1 billion by 2050 (FAO, 2009). To prepare for food security and sustainable agricultural production; therefore, managing technology advancement must be utilized to provide farmers with tools and resources in making farming more sustainable. Modern technologies in agricultural systems have been given an important role for the improvement of agricultural productions e.g. crop yield, fertilizer use efficiency, and sustainable agriculture, in order to maintain food security. It has been known that modern agricultural technology around the world; such as, precision agriculture technology (PA) has been increasing the agricultural productivity. The PA is a comprehensive program that provides a solid background in the high-tech practices, equipment, and software being utilized in production agriculture. In PA, variable-rate application (VRA) of fertilizer allows a prescribed rate of fertilizer to be applied at each location within the field only where and exact amount that plant needed which is based on soil test or remote sensing (RS) data analysis results, so PA can reduce input and cost and save environment from over fertilization (Clay et al., 2017). An unmanned aerial vehicle (UAV) mounted multispectral camera is one high technology used for PA as a tool that can capture highly accurate images and provides RS data of fields, covering up to hundreds of hectares/acres in a single flight and greater resolution than satellite imagery provides, even when there is cloud cover (Colomina and Molina, 2014; Balafoutis et al., 2017). That device can be used to provide accurate, on demand data throughout the year. RS data that recorded by camera on UAV can be used to assist farmers for decision making on farm management, which is done by matching inputs based on actual yields of different portions on the field. Using of PA is widely used in agriculture. Some countries, such as the US, Israel, and Australia, are well on the road towards robotic use in agriculture. Thailand is still in the initial stages. Therefore, for food security, sustainable agricultural system and protect environment Thailand have to build the capacity on modern technologies in agricultural systems; especially, PA.

3. STATEMENT OF PROBLEM:

Thailand is an agricultural country and one of the largest global food exporters; however, agriculture in the country is relied on traditional agricultural system that utilizes high input, labor, and sometime damages environment. Most of agricultural lands in Thailand are in rain-fed areas (FAO, 2006). Farmers are using uniform fertilization with high rate in order to get high yield. However, the productivities of most economic crops have not improved. The increasing of product per area is mostly due to intensive land utilization; for example, double cropping, not rather than high efficiency input utilization. Furthermore, currently, agricultural in Thailand is confront with labor shortage. Some chronic problems in agricultural production; for example, inefficiency of fertilization and labor shortage may be solved by using modern agricultural technology like PA.

Inefficiency of fertilization is one and crucial problem in Thailand. This problem cause both farmers' poverty and environment degradation. Over-fertilization wastes of money and causes environmental pollution. Application an unbalanced composition of nutrients in fertilizers on poor soils has shown limited impact on yield increase. In reality, nutrients in fertilizers do not all end up in the plant; up to 20–80 % of nutrients in fertilizers may be lost to the environment or temporarily accumulate in the soil due to several complex soil chemistries that preclude their immediate availability to the plant (Colomina and Molina, 2014; Balafoutis et al., 2017). There is, therefore, no doubt that producing fertilizers with better plant uptake potential would reduce nutrient loss, in turn reducing the amount of fertilization. Precision agriculture emphasis is placed on improving the use efficiency of fertilizers through the 4R Nutrient Stewardship principle, i.e. the use of fertilizer from the right source, at the right rate and at the right time, with the right placement. Therefore, given the essentiality of fertilizers to secure sufficient food, there is an urgent need for revisiting the concept of fertilizers, to reduce its environmental footprint while making them more economically efficient for resource-poor farmers. Variable rate fertilizer application allows crop producers to apply different rates of fertilizer at each location across fields (Ehmke, 2012). In addition, shortage of labor in agricultural segment in Thailand is more critical. Agricultural employment declining as young people leave farming and their parents are ageing, there is also a concern about the future of older farmers. Full-time farmers are even fewer, as most farmers have taken up a second occupation. A large pool of trainable and inexpensive laborers began to move out of agriculture into more remunerative activities arising from the boom in industry, where the average real wage was much more attractive. Thus, the employment rate in agriculture declined consistently overtime (Poapongsakorn et al., 1998).

PA and other advance technology such as UAV and RS are the emerging technology being adapted for a wide range of applications and may be help people to work faster with minimize workers. UAV can be used for real-time farm monitoring with timely practicing. Because UAV is mounted some equipment on it such as GPS and camera, the receiving data can be used to compare in a time series. It let the farmers know how plant growth and what plant need overtimes. The data that is recorded from UAV can be applied on GIS software that is a rapid advance technology today. RS is the science and art of acquiring information about the earth's surface without actually coming in contact with it. This is done by recording energy, which is either reflected or emitted from the earth's surface. RS; for example, aerial photo can help the scientists and people easier understand the relationship between plant growth and environmental conditions; including rainfall, temperature, soil fertility, soil moisture in a wide area than the past. The information recorded is then processed and analyzed, and the information is used to develop a prescription map that can be used in a variable-rate application. The relationship among RS data, plant phenology, and climate condition can be used to make a prescription map of input. A prescription map is an electronic data file containing specific information about input rates to be applied in every zone of a field. Fertilization control automatic program may relive labor shortage in agricultural sector (Clay et al., 2017; Ahmed et al., 2018).

4. OBJECTIVES:

1. To calibrate some soil quality between chemical analyzed form laboratories with NIR spectrophotometer of soil samples in each treatment.

2. To monitor and collect NIR dataset form NIR spectrophotometer with dataset from UAV aerial imagery of soil and plant samples from each treatment

3. To estimate correlation between content of main plant nutrients and organic matter in soil and plant of each treatment with data analyzed from laboratory, NIR spectrophotometer and NIR form UAV aerial imagery.

4. To estimate possibility to use NIR spectrophotometer and NIR form UAV aerial imagery to monitor and predict growth and yield of rice.

5. PROPOSED APPROACH/ ACTIVITIES AND METHEODOLOGY:

a. PROPOSED APPROACH

1. Study the possibility of precision agriculture for sustainable agricultural system in Thailand

2. Building capacity on technological knowledge to government officers for high technology agricultural system particularly in the context of precision agriculture, UAV, and RS.

3. Study the method to increase agricultural productivities with increasing nitrogen (N) fertilizer use efficiency, low cost, acceptable profit, and environment friendly.

b. ACTIVITIES AND METHODOLOGY

This study effort sought to determine the utilization of remote sensing in detecting rice responsiveness to N fertilizer rates in term of measure leaf nitrogen, biomass, chlorophyll content and yield. A three-year study experiment will be performed on rice commercial farm in Thailand. First two years of the experimental will be study the response of rice on N rates, and the final year of the experimental will be study the efficiency of the model using for N-prescription for precision rates. The activities and methodology are following;

Calibration of some soil quality: between chemical data analyzed form laboratory with from NIR spectrophotometer of soil samples in each treatment.

1. Site selection: the experiment will be performed on farm where rice is commercial crops in Nakhonnayok Province, Thailand. The experimental site will be covered an area of 0.8 hectares (5 rai). Site description will be defined, for example, soil type, rain fall, temperature, etc.

2. Site characterization: the experiment will be conducted using a randomized complete block design with 5 treatments and 3 replications as following;

Treatment 1: control plot

Treatment 2: half N rate recommend for Pathumthani-1 rice

Treatment 3: full N rate recommend for Pathumthani-1 rice

Treatment 4: Double N rate recommend for Pathumthani-1 rice

Treatment 5: Soil test N prescription.

3. Soil data collection: soil data will be collected four times; such as prior to plantation and fertilization, before first top dressing fertilization, at rice panicle initiation stage, and after harvesting. Soil samples will be collected 12 cores per plot. Each core will be marked location using a ground positioning system (GPS) device. All sample will be analyzed; Nitrogen, Phosphorus, Potassium, pH and organic matter.

Monitor and collect soil and plant samples for NIR dataset: All of soil and plant samples are collected from each treatment of this research project.

1. Aerial imagery collection and processing: multispectral aerial imagery will be acquired coincident with ground sampling by a digital camera mounted on UAV. The images will be consisted of 4 wavelength bands including green (550±40nm), red (650±40nm), rededge (717±40nm), and near infrared (850±40nm) with 10 centimeter spatial resolution. The images will be acquired triple times; such as, prior to plantation and fertilization, before first top dressing fertilization, and at rice panicle initiation stage. All

images will be geometrically corrected, band combined, and vegetation indexes (VIs) calculated by using geographical software.

2. Plant data collection: plant samples are analyzed data; biomass, Nitrogen, Phosphorus, Potassium, relative chlorophyll content, which are collected twice times at the same location of soil samples, before first top dressing fertilization and at rice panicle initiation stage. The relative chlorophyll content of leaves will be measured using a chlorophyll meter and chemical properties of plant samples are analyzed by NIR spectrophotometer at laboratory of Land Development Department.

3. All of soil and plant samples are collected and analyzed by NIR spectrophotometer in laboratory. And also RS NIR data are collected by using UAV aerial imagery, which 2 datasets are estimated correlation.

Estimation relationship between soil and plant nutrients: Nitrogen, Phosphorus, Potassium and organic matter in soil and plant samples of each treatment with data analyzed from laboratory, NIR spectrophotometer and NIR form UAV aerial imagery.

1. Data analysis: Linear and non- Linear regression models will be used to describe relationships between fertilizer N treatments and Vis, relative chlorophyll content, leaf N content, biomass, and yield. The r^2 and p-values of each relationship will be compared to determine the goodness of fit for regression model.

2. Model for spatial variable N rates prescription testing: on-farm testing will be performed in a final year. The aerial imagery will be collected and processed before first top dressing fertilization and relate to a model derived from the previous experiment to make a spatial related variable N rates prescription map. At rice panicle initiation stage, soil data, aerial imagery, biomass, leaf, and the relative chlorophyll content will be collected. At harvesting, soil data, biomass, and yield will be collected. The r^2 and p-values will be used to verify the model fitting.

Estimate possibility to monitor growth and yield of rice: Dataset from NIR spectrophotometer and NIR form UAV aerial imagery are estimate correlation with growth and yield of rice.

1. Plant samples are collected from each treatment at the same location of soil samples. Biomass, leaf color, and the relative chlorophyll content of rice will be collected 2 times, before first top dressing fertilization and at rice panicle initiation stage. Moreover, yield of rice in each treatment is also collected. These all rice data are used in the next step to estimate correlation with NIR data.

2. Both datasets form NIR spectrophotometer and UAV aerial imagery are estimate correlation with biomass, leaf color, and the relative chlorophyll content and yield of rice in each treatment. These correlation data will evaluate the possibility to monitor and predict growth and yield of rice by using NIR data from NIR spectrophotometer and RS NIR form UAV aerial imagery.

6. EXPECTED OUTPUTS:

1. Utilization of NIR spectrophotometer analyze some soil properties such as content of Nitrogen, Phosphorus, Potassium and organic matter in soil.

2. Utilization of remote sensing data of NIR form UAV aerial imagery assess such soil and plant properties.

3. Estimation possibility to use NIR spectrophotometer and NIR form UAV aerial imagery to monitor and predict growth and yield of rice, and develop model to make a spatial variable N rates prescription for rice.

7. PROJECT PROGRESS:

The project was started in December 2018. There were some activities done e.g. site selection, soil sampling, and aerial images data collection. The details of each activity are following;

7.1 Site selection

This research was focusing on the improvement of rice production in acid sulfate soil. Therefore, the site selction was started by using soil map of LDD to illustrate soil groups' distribution in Nakhon Nayok province. There are some soil groups classified as acid sulfate soil.

Then, field survey for site selection was done, and a commercial paddy field of farmers in Pak Ple Distric of Nakhon Nayok province was selected (fig. 1).

120 ไร่ 3 งาน 57 ตร.วา.

โซน 47 X=743290.42 Y=1565455.1

Unnamed Road ตำบล เกาะหวาย

Fig. 1 The study site where is a commercial paddy field in sulfate soil located in Pak Plee Distric of Nakhon Nayok Province

7.2 Soil Sampling

Soil samples were collected 80 points within an area of 3 rai (0.48 ha) of the study (fig 1), and each soil sample was designate the location using GPS device. The soil samples were collected using an auger at 0-30 cm depth (fig 2.). All samples was put in plastic bags (fig. 3), labeled, and sent to LDD lab in Bangkok to analyze some soil properties and fertility e.g. organic matter, pH, N, P, and K.

Fig. 1 The 80 points soil sampling within an area of 3 rai (0.48 ha)

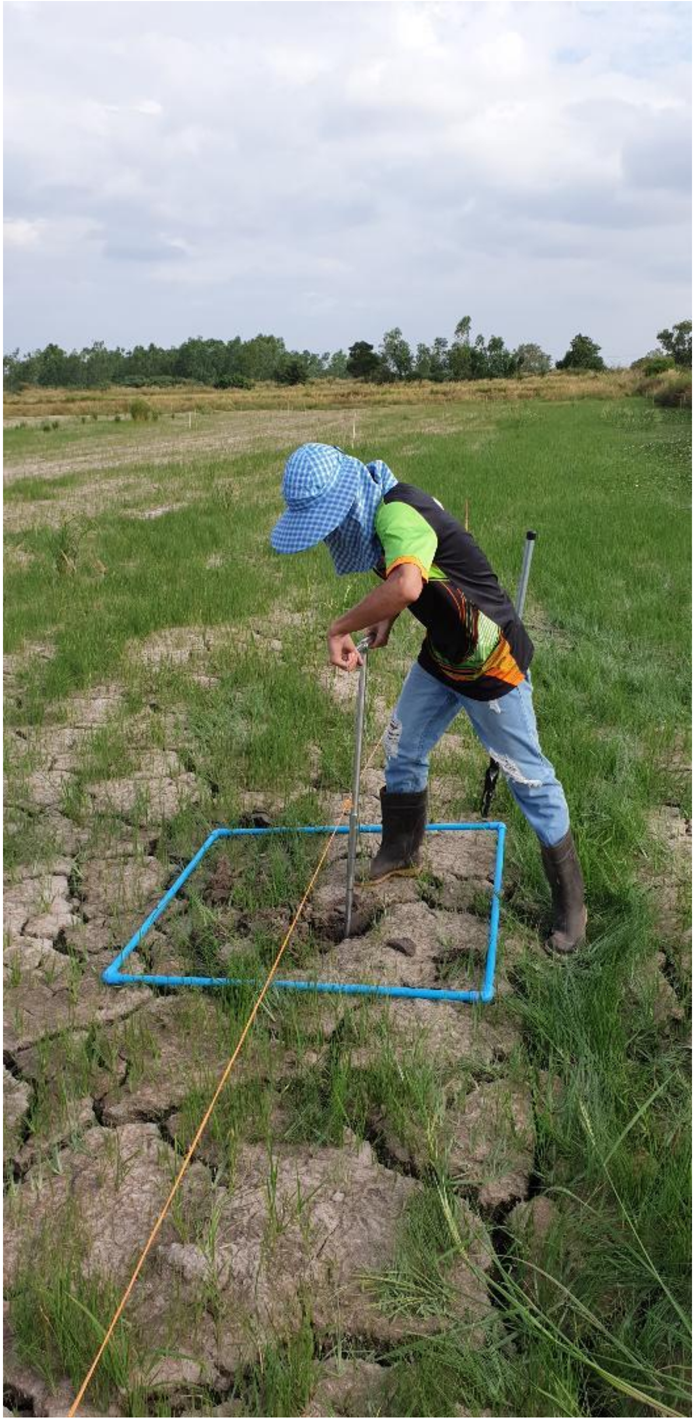


Fig 2. The soil samples were collected using an auger at 0-15 cm depth 80 points within an area of 3 rai (0.48 ha)

Fig 3. All samples was put in plastic bags, labeled and sent to LDD lab in Bangkok

7.3 Aerial Images Data Collection

Aerial images data were collected twice times using drone mounted with multispectral camera (fig.4). The images were covering the commercial paddy fields of farmers with an area of 120 rai (19.2 ha). The first image data was collected on November 29, 2018: the study area was bare soil and covered with some grasses (fig 4, 5, and 6). The second image was collected on March 2, 2019: rice was 40-50 day-old (fig 7).

Fig 4. A drone mounted with multispectral camera

Fig 4. A true color aerial image collected using a drone mounted with multispectral camera

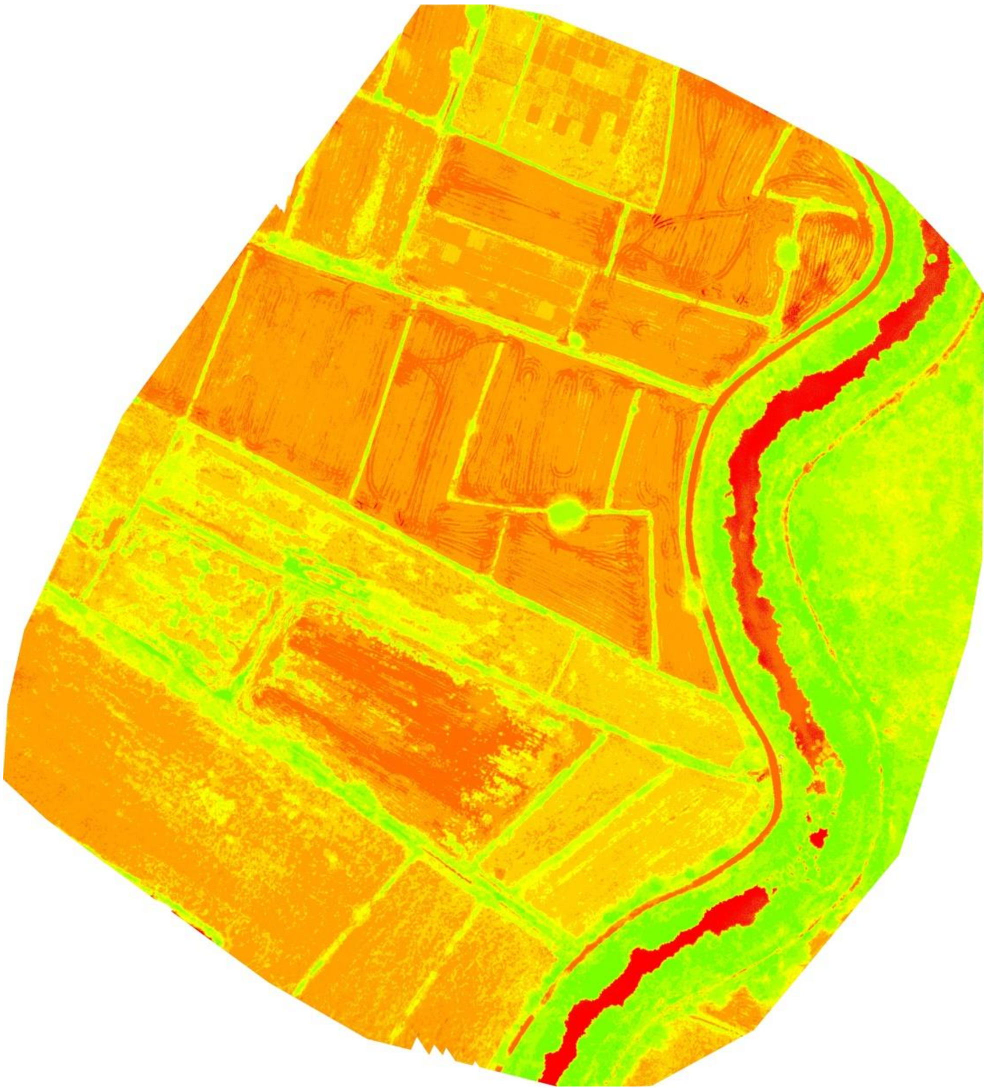


Fig 5. The NDVI aerial image collected using a drone mounted with multispectral camera

Fig. 6 The study area was bare soil and covered with some grasses on November 29, 2018

Fig. 7 Rice was 40-50 day-old on March 2, 2019

8. Results

The study of the variation of soil chemical properties within the study area

Soil samples that were collected from 80 points across the study area were anlyzed by LDD lab. The soil analysis results ware generated maps by using IDW interpolation. The details of each soil chemical properties are following;

8.1 the variation of soil pH

Soil pH map is shown in fig. 8. It is in a range from 3.8 to 4.6. However, the most of the stusy area is in range from 4.28 to 4.35 (fig. 9).

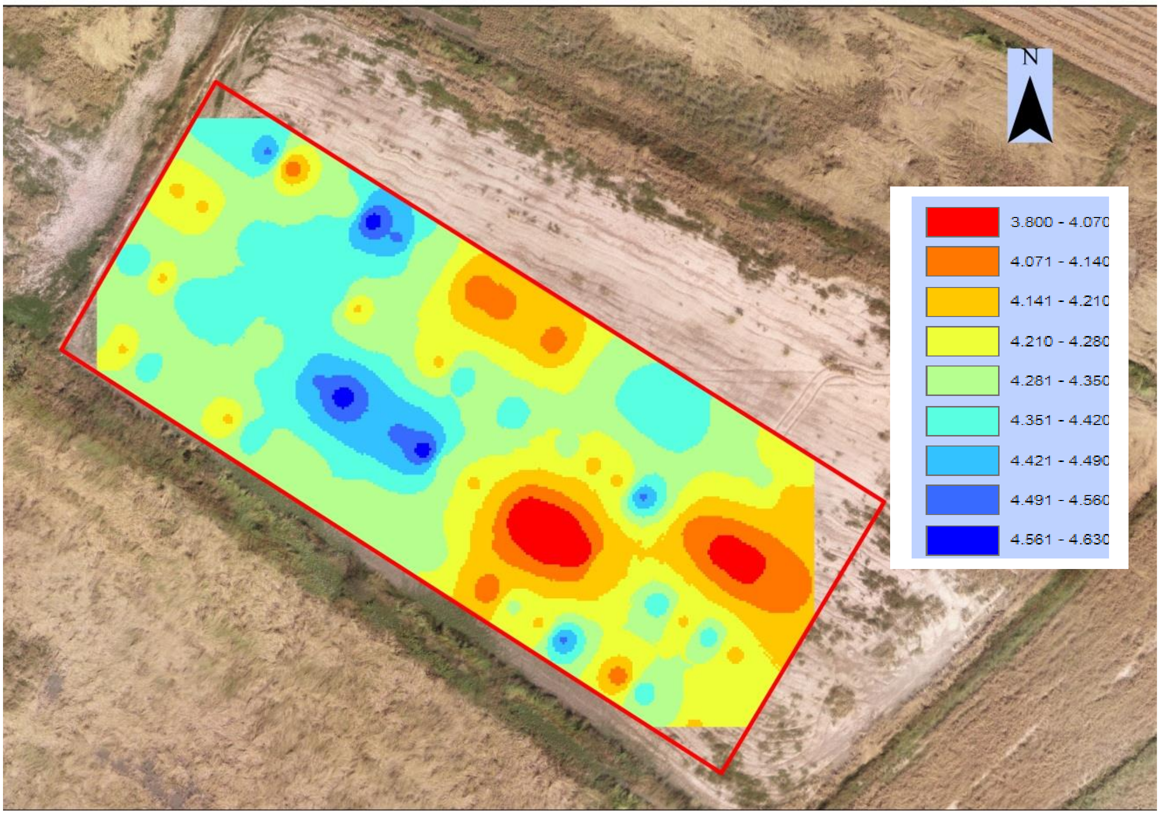


Fig. 8 The variation of soil pH within the study area

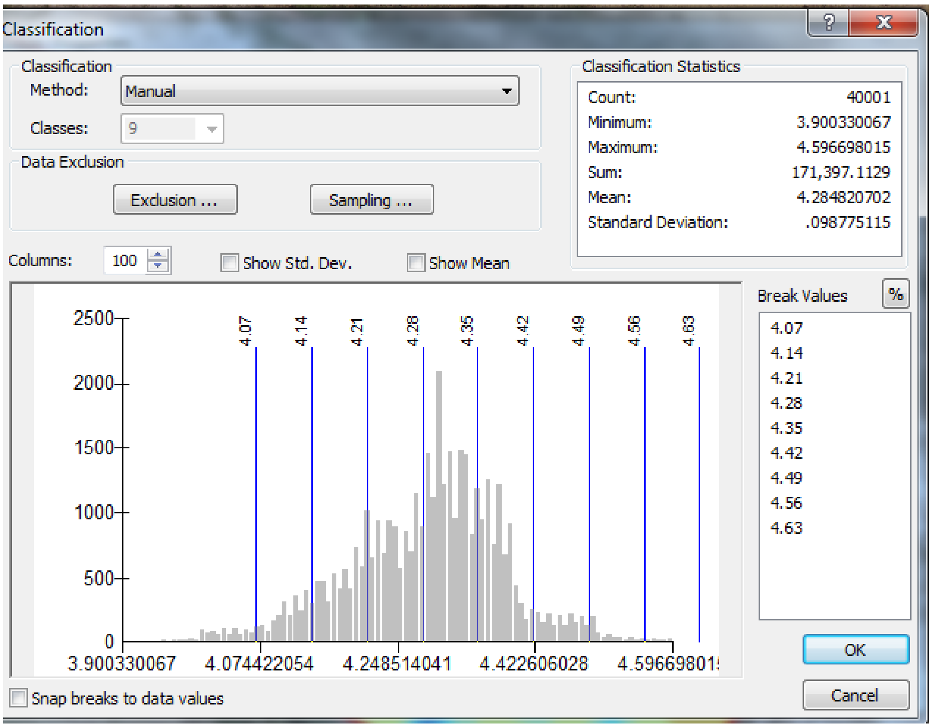


Fig. 9 The satatistic of soil pH variation within the study

8.1.2 The variation of soil organic matter (OM)

Soil OM map is shown in fig. 10. It is in a range from 1.10 to 3.23. However, the most of the stusy area is in range from 1.7 to 2.3 (fig. 11).

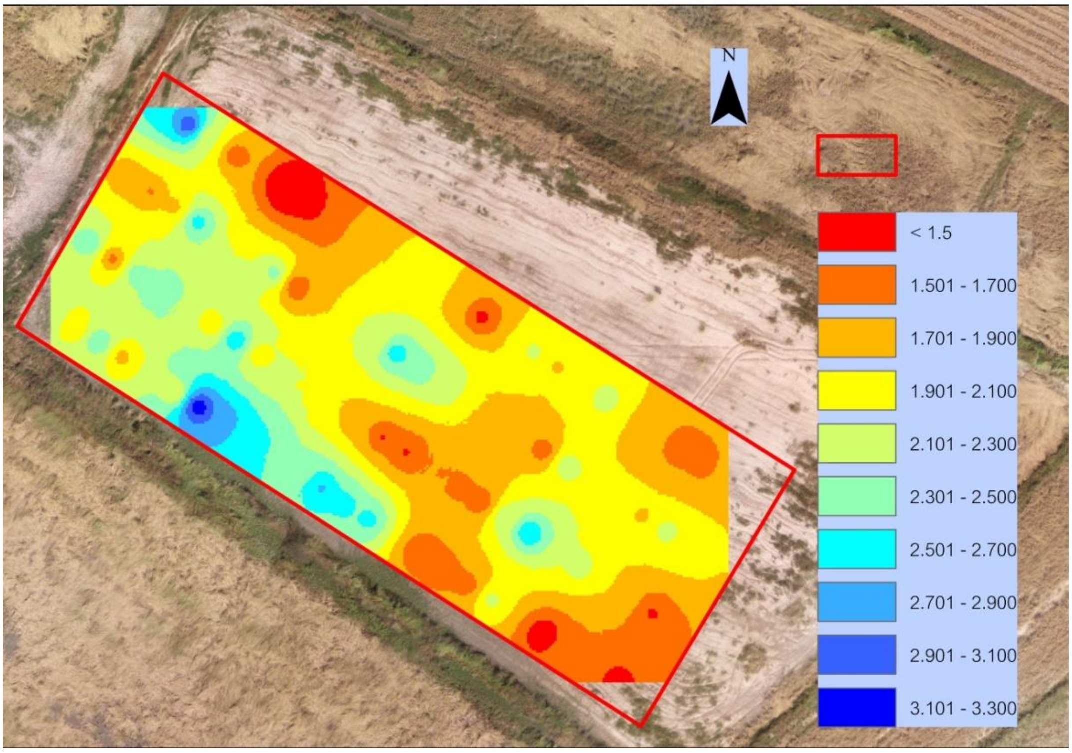


Fig. 10 The variation of soil OM within the study area

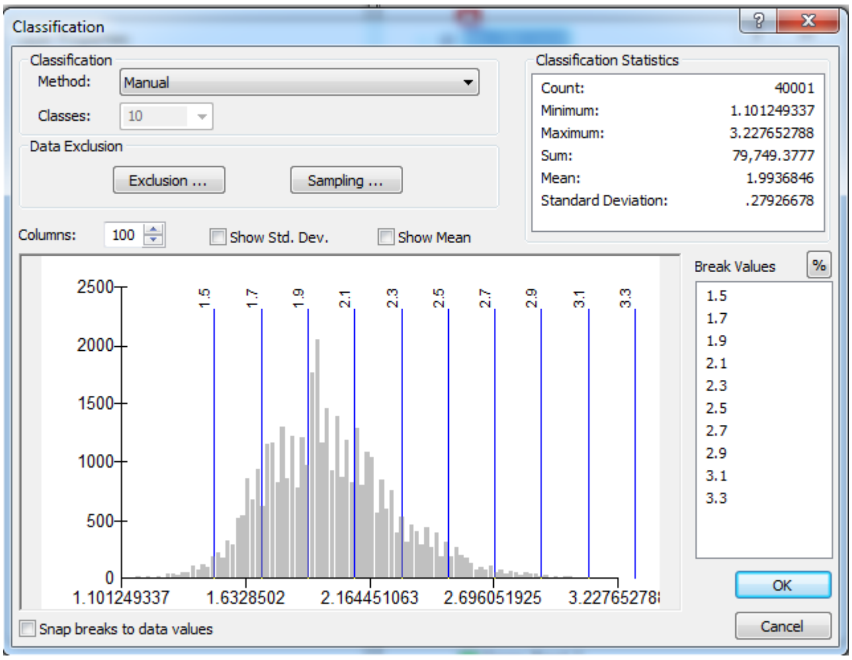


Fig. 11 The satatistic of soil OM variation within the study

8.1.3 the variation of soil EC

Soil EC map is shown in fig. 12. It is in a range from 0.09 to 2.72. However, the most of the stusy area is in range from 0.09 to 0.20 (fig. 13).

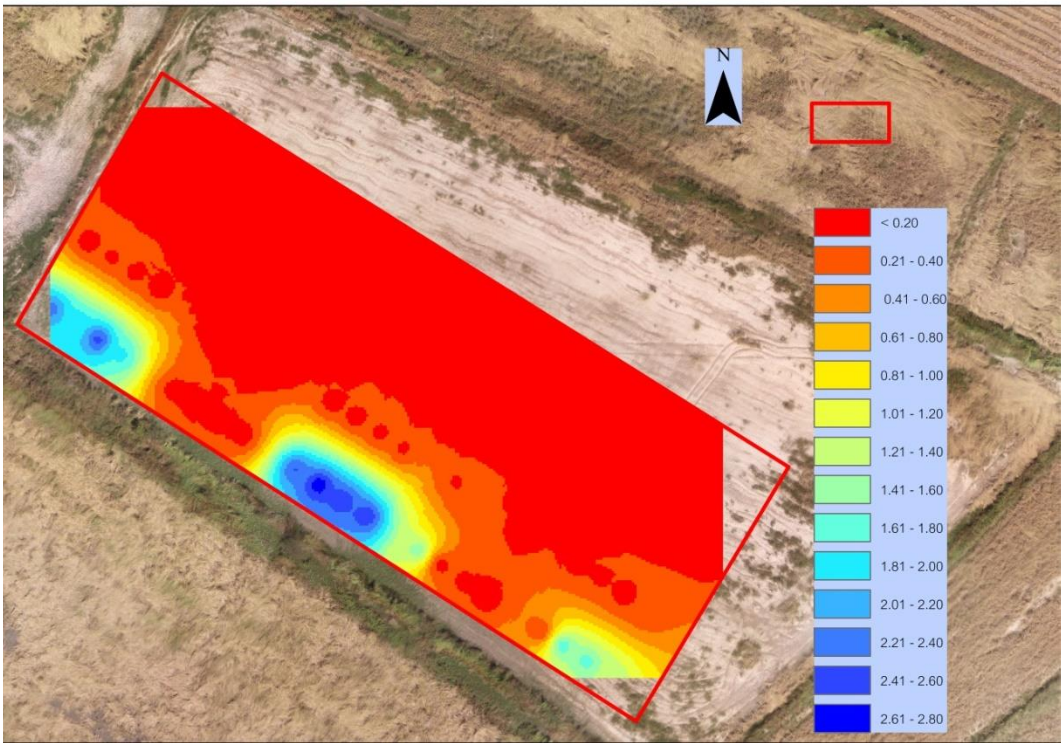


Fig. 12 The variation of soil EC within the study area

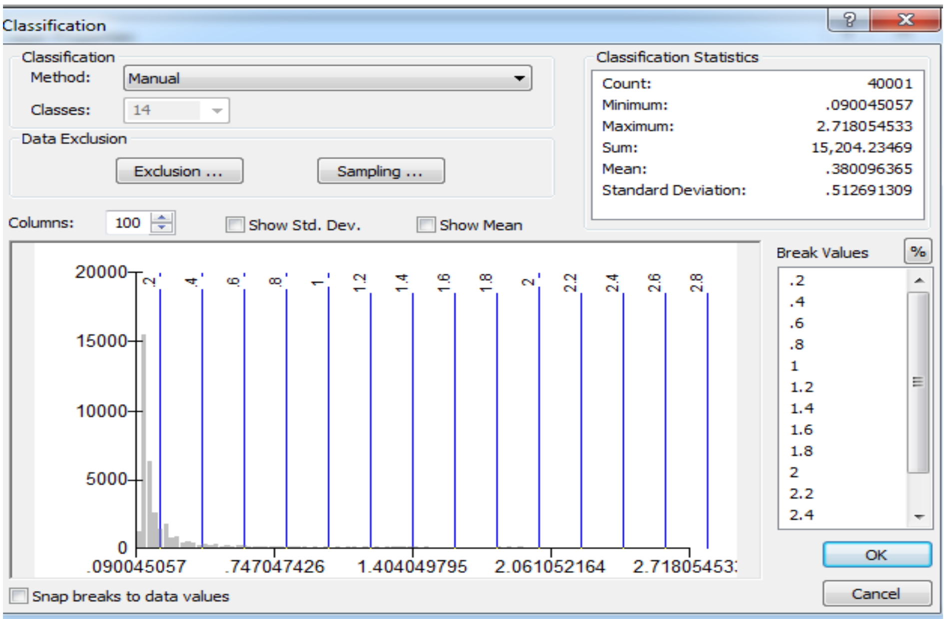


Fig. 13 The satatistic of soil EC variation within the study

8.1.4 the variable of soil phosphorous (P)

Soil P map is shown in fig. 14. It is in a range from 3.00 to 15.98. However, the most of the study area is in range from 3.00 to 7.50 (fig. 15).

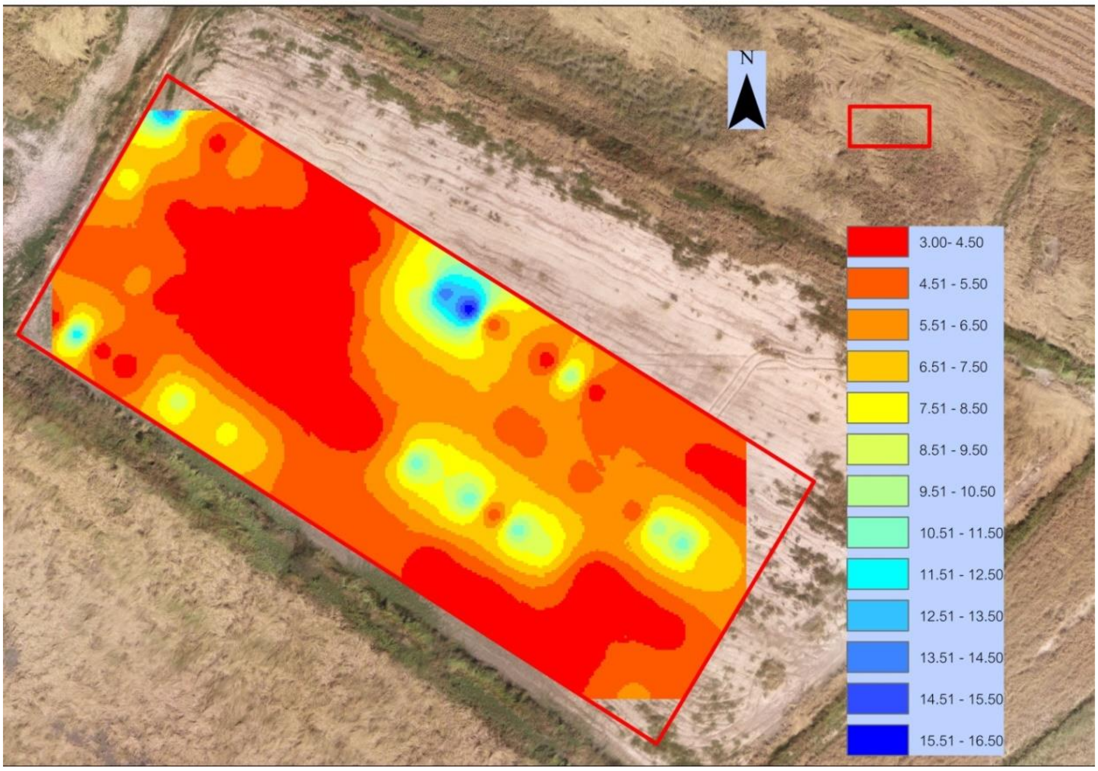


Fig. 14 The variation of soil P within the study area

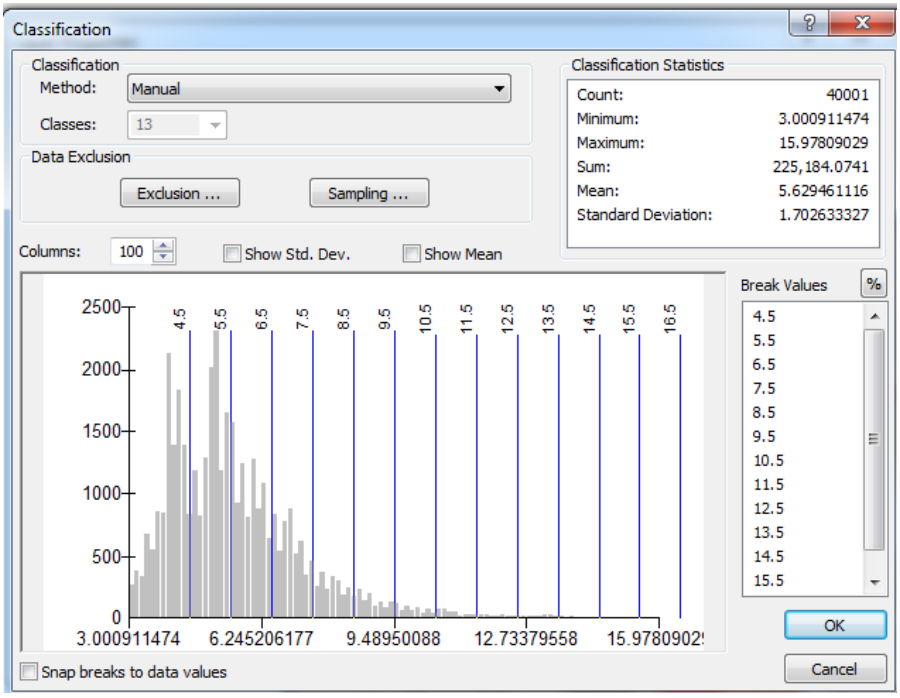


Fig. 15 The satatistic of soil P variation within the study

8.1.5 the variable of soil potassium (K)

Soil K map is shown in fig. 16. It is in a range from 39.41 to 68.53. However, the most of the study area is in range from 49.00 to 57.00 (fig. 17).

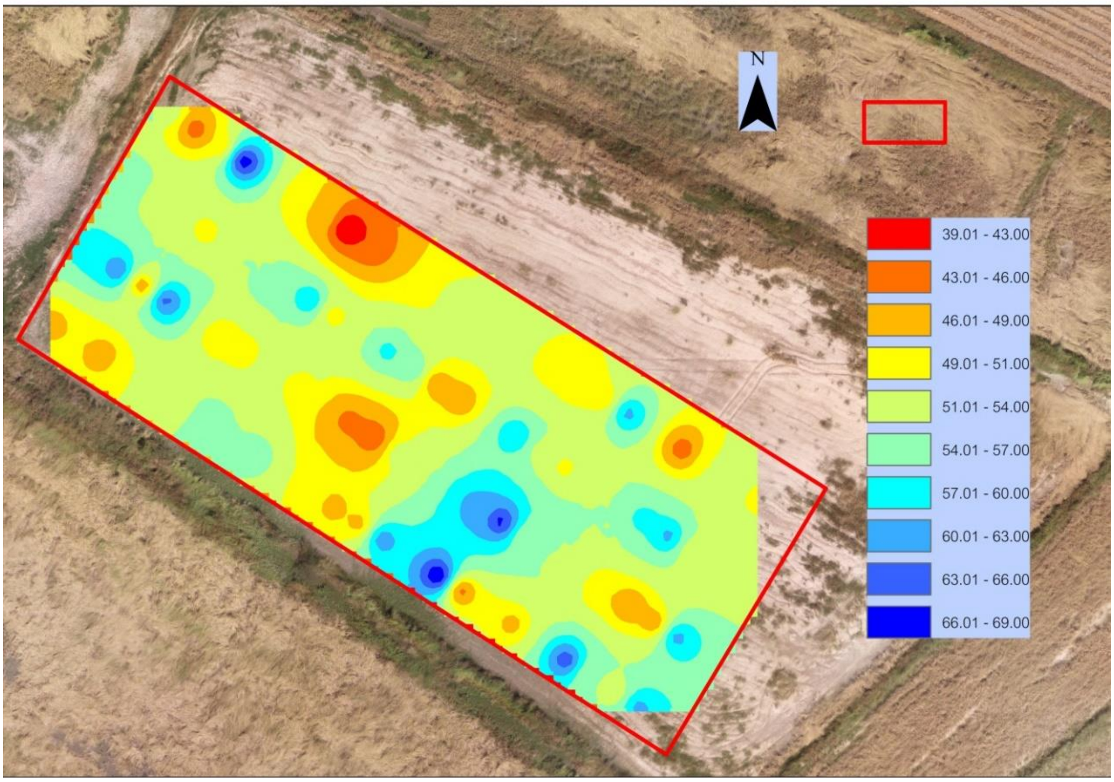


Fig. 16 The variation of soil K within the study area

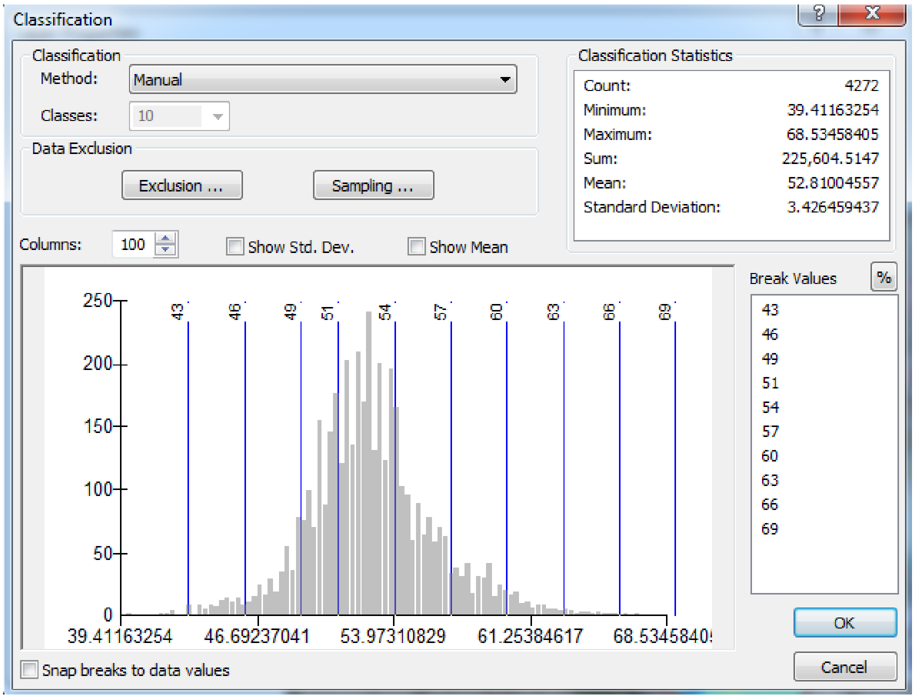


Fig. 17 The satatistic of soil K variation within the study

8.1.6 the variable of soil calcium (Ca)

Soil Ca map is shown in fig. 18. It is in a range from 452.31 to 1,532.92. However, the most of the study area is in range from 600.00 to 1,200.00 (fig. 19).

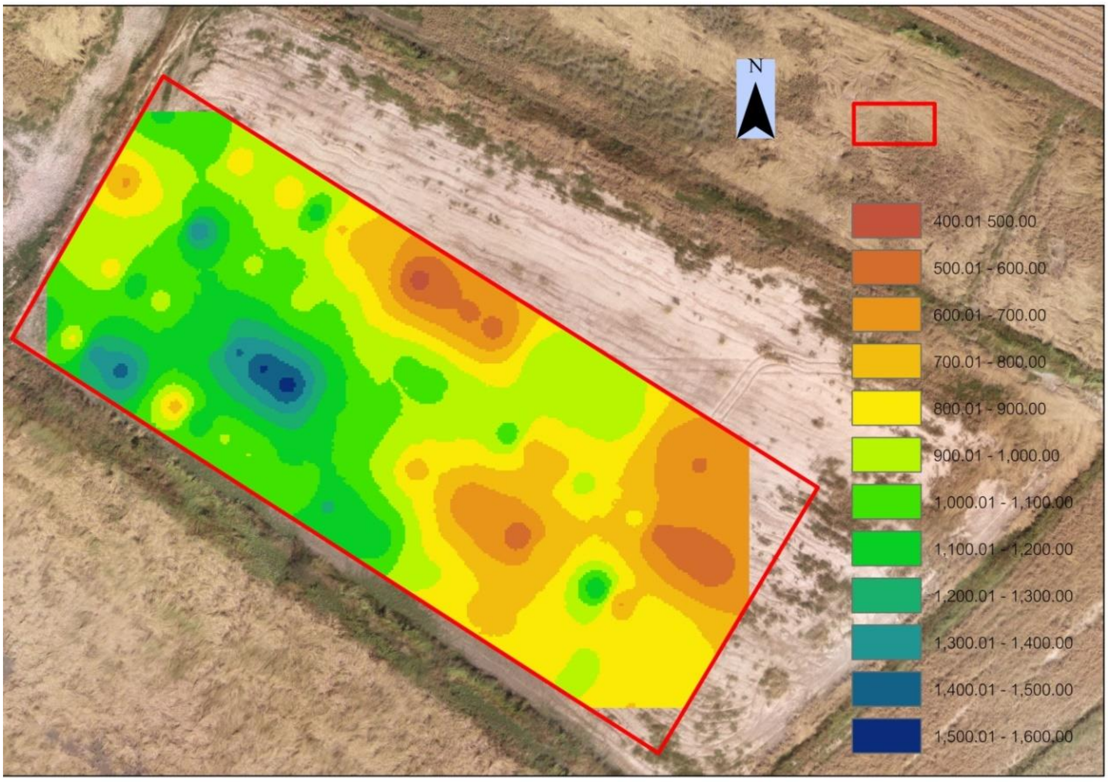


Fig. 17 The variation of soil Ca within the study area

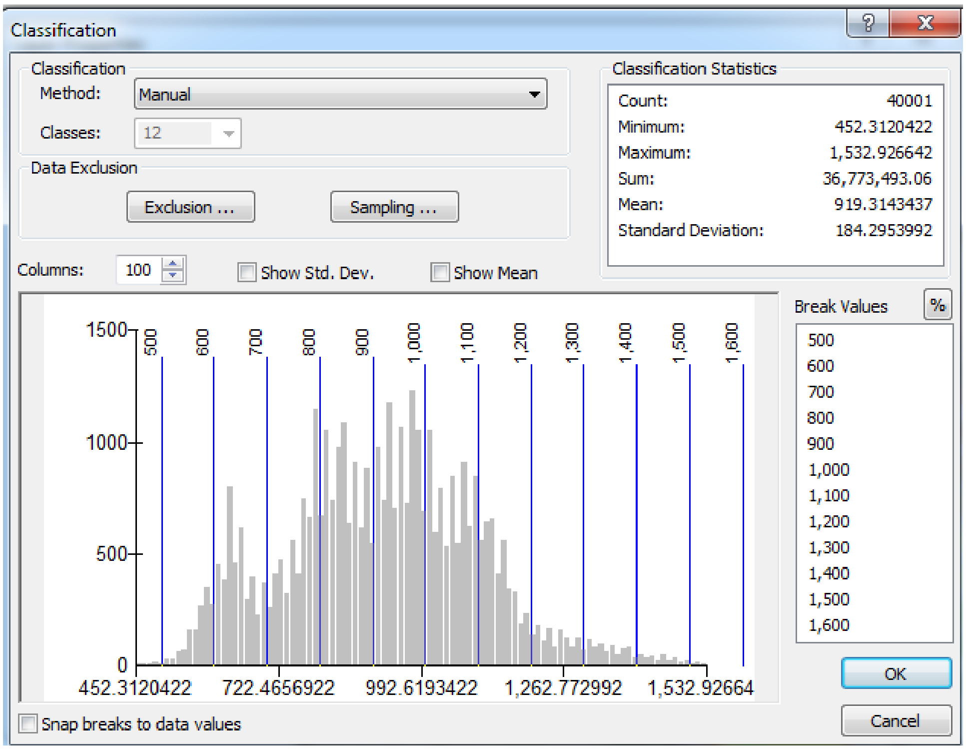


Fig. 18 The satatistic of soil Ca variation within the study

8.1.7 the variable of soil magnesium (Mg)

Soil Mg map is shown in fig. 19. It is in a range from 180.12 to 578.80. However, the most of the study area is in range from 240.00 to 360.00 (fig. 20).

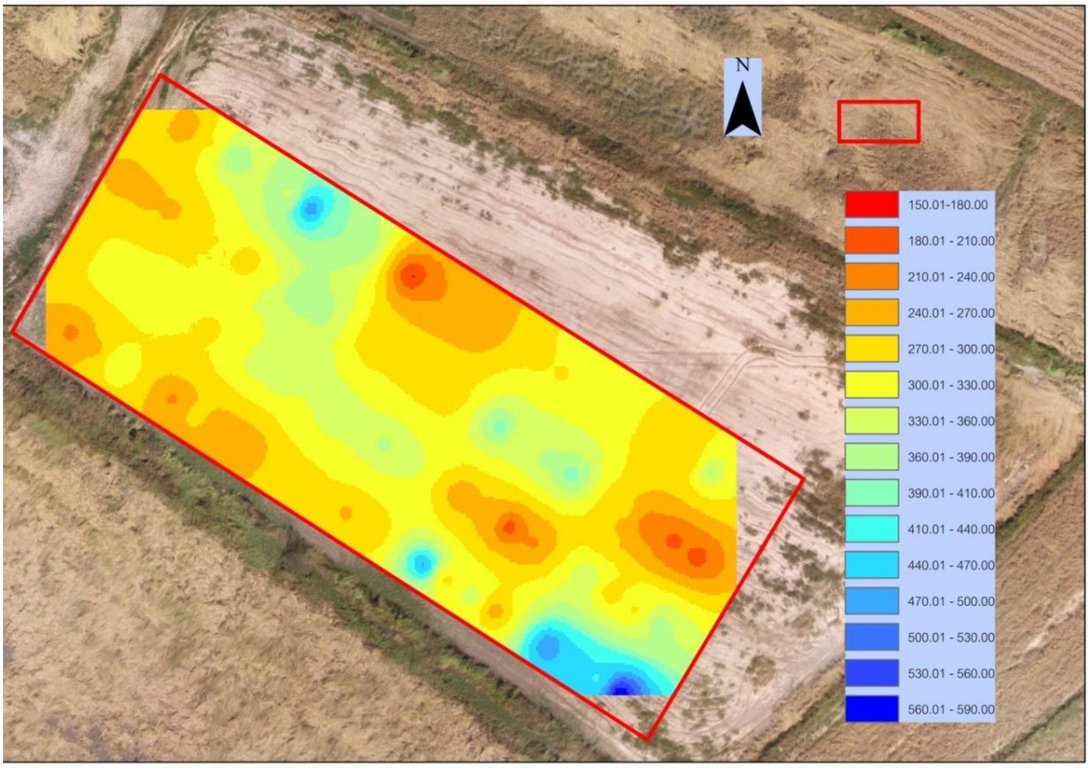


Fig. 19 The variation of soil Mg within the study area

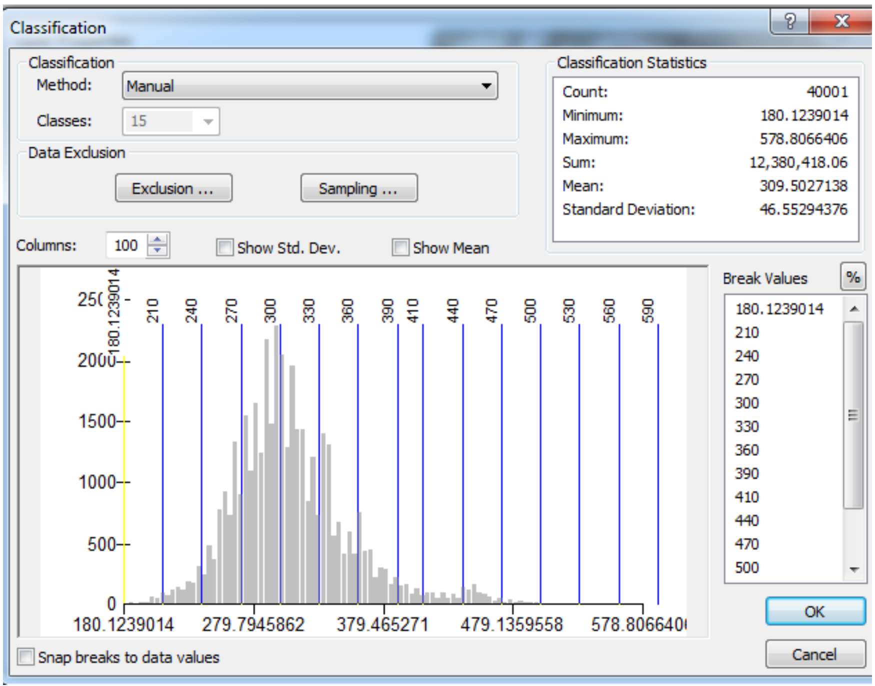


Fig. 20 The satatistic of soil Mg variation within the study

9. REFERENCES

Ahmed, M.Z., S.A. Munneer, H.A. Salam, D.V.P. Mani. 2018. IoT based Smart Automation using Drones for Agricultures. IJSDR Vol.3 Issue 1January 2018, pp. 66-70.

Balafoutis, A., B. Beck, S. Fountas, J. Vangeyte, T. van der Wal, I. Soto, M. Gómez-Barbero, A. Barnes, and V. Eory. 2017. Precision Agriculture Technologies Positively Contributing to GHG Emissions Mitigation, Farm Productivity and Economics. Sustainability 2017, 9, 1339. 28p.

Clay, D. E., A. A. Clay, S. A. Bruggeman. 2017. Practical Mathematics for Precision Farming. ASA CSSA SSSA. Madison, WI, USA. 271p.

Colomina, I. and P. Molina. 2014. Unmanned aerial systems for photogrammetry and RS: A review. ISPRS Journal of Photogrammetry and Remote Sensing 92 (2014) 79–97.

Ehmke, T. 2012. 4R nutrient management. American Society of Agronomy. Crops & Soils magazine. Sep.–Oct. 2012.

FAO. 2006. The decline and recovery of Thai agriculture: causes, responses, prospects and challenges. Regional Office for Asia and the Pacific. Food and Agriculture Organization of the United Nations. Available on

http://www.fao.org/docrep/009/ag089e/ag089e06.htm.

FAO. 2009. Global Agriculture towards 2050. How to Feed The Word 2050. High-Level Expert Forum. Rome, 12-13 October 2009.

Poapongsakorn, N., M. Ruhs, and S. Tangjitwisuth. 1998. Problems and Outlook of Agriculture in Thailand. TDRI Quarterly Review Vol. 13 No. 2 June 1998, pp. 3-14.

PROJECT 2

2.1 Assessment of land degradation by using Land Degradation Neutrality (LDN) compare with Land Degradation Assessment in Drylands (LADA) method in Mae Kham watershed, Chiang Rai Province, Thailand.

Somjit Lertdisayawan, Sasirin Srisomkiew, Preeyarat Chailangka and Pitayakon Limtong

1. INTRODUCTION

Land degradation refers to changes in the chemical, physical and biological properties of soil due to the lack of soil management which results in permanent reductions in soil quality for agricultural production. The decline of the soil quality appears in many forms, such as soil fertility and soil organic matter which affects the top soil, the most suitable for planting. Soil fertility and productivity in Thailand, especially in agricultural areas, have been declining. The decline rate seems to have significantly increased in recent years. Many government agencies have set up several development projects to solve these land degradation problems. The United Nations Convention to Combat Desertification (UNCCD) provides the Land Degradation Neutrality (LDN) Target Setting Program for assessment of land degradation trends. The LDN assessment has three indicators that used for setting the baseline of land use/cover, land productivity and soil carbon stock. The Land Degradation Assessment in Drylands (LADA) project established the methodology for the assessment and mapping of land degradation. The LADA assessment is carried out at three spatial scales (local, national and global) and considers land degradation status, drivers and impacts within land use systems (LUS). The results of LADA provide a better understanding of the degradation phenomena and gives indications for appropriate responses at all levels of scale.

2. PROJECT GOAL

This study would like to follow UNCCD guideline to generate the risk area to assess of land degradation by using the three LDN indicators and compare with the LADA method using LUS map with the World Overview of Conservation Approaches and Technologies (WOCAT)'s questionnaire to identify the hot and bright spots of the land degradation in Mae Kham watershed, Chiang Rai Province, Thailand. The research site is located in the north of Thailand with a total area of 7,298,981 rai. The area is not suitable for agriculture, but there is still demanding to use the area for agriculture as the plain areas are limited. This research project will help to identify the risk area of land degradation by using up-to-date and near-real-time databases to generate the land degradation map and use some suitable measure and sustainable land management in the study area. This information is useful in solving the problem of soil degradation and appropriate land use planning in the future.

3. THE OBJECTIVE

1. Assessment of land degradation by using LDN compare with the LADA method using LUS map with the WOCAT's questionnaire to identify the hot and bright spots in Mae Kham watershed, Chiang Rai Province, Thailand.
2. Evaluation of risk management and appropriate sustainable soil management in Mae Kham watershed, Chiang Rai Province, Thailand.

4. PROGRESS AND DATA PREPARATION

4.1 Land Use Data

In this study, land use change in Chiang Rai will be evaluated from THEOS and LANDSAT satellite images. The THEOS satellite images (2 m resolution) acquired in the year 2007 and 2018. They will be used for accurate land use/cover interpretation in the study area. Landsat 8 satellite images (2 m resolution) in the year 2007 and 2018 will be used for land use type identification in the field survey. LANDSAT 8 satellite images can be downloaded and satellite data will be corrected in the geometric correction process. The THEOS satellite image can be ordered from GISTDA and get the satellite images in mid-December.

4.2 Land Use Change Analysis

Land use represents the human use of land. Land cover represents biophysical cover. They are a main parameter to estimate land use changes. Land use change is the use of a particular land which is changed from one to another over time. Trends of Land use/cover change in Chiang Rai province is divided into 6 classes of land use pattern for 2007 and 2018.

At this stage, researchers are required to conduct field surveys with THEOS and Landsat 8 satellite imagery interpretation. Next step, edit the shapefile in ArcGIS program. The various land use/cover in the study area will classify in to 6 classes are Cropland, Forest land, Grassland, Settlements, Wetlands and Other land.

4.3 Land Productivity Analysis

The assessment of land productivity changes by using NPP data in 2007 and 2018 will be analyzed by remote sensing data from MODIS satellite images, which estimate into 3 classes are high, medium, and low in Chiang Rai province. For MODIS satellite image data will be download and classify by using QGIS program next month.

4.4 Soil Carbon Stock Analysis

Changes in soil organic carbon (SOC) generally occur over many years, and it is often difficult to identify small changes. For this study will use the secondary data which are available from the Land Development Department (LDD). Soil Carbon Stock is calculated from the measured total percentage of organic carbon in the soil and will be done after getting the SOC data.

4.5 LADA Assessment

The LADA assessment of land degradation in local level is used to identify the hot and bright spots of land degradation in Mae Kham watershed, Chiang Rai Province. The boundary of LUS is classified by the LUS team of Decision Support for Mainstreaming and Scaling up Sustainable Land Management (DS-SLM) Thailand project. Some of such data of the local level in this study area will be used in this LADA assessment activities. The next step, all of such data will be generated by using the ArcGIS and QGIS program. The hot and bright map in the study area will be generated after several estimated data and analyzed by the method of LADA assessment. These dataset and digital land degradation map will compare with LDN assessment under UNCCD project.

2.2 Estimation of soil erosion by using Soil Loss Equation with Leaf Area Index (LAI) in some conservation measures

1. INTRODUCTION

Soil erosion is a severe problem in agriculture on a global scale. Vegetation controls soil erosion rates significantly where water erosion is decreased by increasing vegetation cover. The value of soil-protectiveness is dynamic, pointing out that plant anti-erosion activity begins at 20–30% of soil covered. Leaf Area Index (LAI) is an important biophysical vegetation parameter which LAI is the ratio of upper leaf surface area to ground area (m^2/m^2). This ratio can be related to gas-vegetation exchange processes such as photosynthesis, evaporation and transpiration, rainfall interception, and carbon flux. The long-term monitoring of LAI can provide an understanding of dynamic changes in productivity and climate impacts. LAI can be measured on the ground by collecting leaf tissue and measuring the leaf surface area or by various indirect techniques. This research uses remote sensing data of LAI as a cover-management factor (C-factor) in Universal Soil Loss Equation (USLE) model. It is useful to estimate LAI from remotely sensed images. LAI is difficult to directly acquire for large spatial extents because its time consuming and work intensive nature.

2. PROJECT GOAL

The study will use the USLE to estimate soil erosion by using the LAI from Terra MODIS Satellite. Then predict the amount of soil loss and compares soil loss from non-conservation and conservation measures in Mae Kham watershed, Chiang Rai Province, Thailand. The GIS-based on the USLE methodology will help to identify the spatial distribution of different erosion areas and it can be used for suitability of soil conservation planning in the area. Moreover, watershed management which is soil erosion and water conservation controlling in the agricultural area.

3. THE OBJECTIVE

1. Using remote sensing data of LAI as the cover-management factor (C-factor) in USLE model.

2. To estimate soil loss in large areas and point which areas are very high risk of soil erosion every 8-16 days.

3. To estimate soil erosion in Mae Kham watershed by using USLE equation with LAI in some conservation measures compare with non-conservation measure.

4. PROGRESS AND DATA PREPARATION

Estimation of soil loss from USLE method commonly recommended by FAO.

USLE (A = RKLSCP)

Where:
- R factor = the rainfall erosivity factor
- K-factor = the soil erodibility factor
- LS-factor = the slope length and slope steepness factor
- C-factor = the cover management factor
- P-factor = the conservation practice factor

4.1 The rainfall erosivity factor (R factor)

The rainfall erosivity (R factor) is the principal function of USLE. The maximum rainfall intensity for 30 years express as a kinetic energy of rainfall which is used to compute the R factor. The preparation of the data for the rainfall cover the study area will use from the Meteorological Department of Thailand. Then calculate the rainfall data by using datasheet program for generating such R factor.

4.2 The soil erodibility factor (K factor)

A monogram developed by Wishmeier and Smith was used to obtain the value of the K factor on the basis of the percentages of silt, very fine sand, organic matter; soil structure and soil permeability. In this study, K-factor based on 62 LDD's soil groups and the geology of Thailand.

4.3 The slope length and slope steepness factor (LS-factor)

The slope length and slope steepness factor (LS-factor) using the Shuttle Radar Topographic Mission (SRTM) at 90 m. The SRTM will be downloaded from the website. Then analyze the slope value with the r. watershed module in QGIS program.

4.4 The conservation practice factor (P-factor)

For the P-factor in this research will assume that the non-conservation practice in the study area is 1.

4.5 The cover management factor (C-factor)

In this study will use LAI to be the C-factor and compare with the C-factor from land use data. LAI is an important biophysical vegetation parameter. LAI is the ratio of upper leaf surface area to ground area (m2/m2). This ratio can be related to gas-vegetation exchange processes such as photosynthesis, evaporation, transpiration, rainfall interception, and carbon flux. Long-term monitoring of LAI can provide an understanding of dynamic changes in productivity and climate impacts. LAI will be generated from the MOD15A2H version 6 MODIS Level 4, Fraction of Photosynthetically Active Radiation (FPAR), and LAI product, which is an 8-day composite dataset with 500 m pixel size.

The MODIS which cover all the study area in Mae Kham watershed of Chiang Rai Province, Thailand was downloaded from the website. Next step, all satellite images will be generated by using ArcGIS and QGIS program.

APPENDICES

The DS SLM Thailand implementing national agency is the Land Development Department (LDD) under the Ministry of Agriculture and Cooperatives (MoAC). Two national partners, the Soil and Fertilizer Society of Thailand (SFST) and Kasetsart University, as well as several key national experts that have contributed to the implementation of the Project.

The DS SLM Project results provide a good model of a national project that supports national capacity to develop, assess and analyze the national land degradation data that can be reported to the global databases such as the FAO and WOCAT databases that are already part of the UN CCD work stream.

The preparation and participatory process of the DS SLM Project Land Use System (LUS) Map among different Departments of the MoAC is an example of an inter-agency collaboration that can contribute and can be adapted by the Thailand UN CCD processes in developing baseline data and periodic monitoring of the LDN indicators (land cover – analysis of diverse data) in the national and local level .

The activities implemented by the DS SLM for sustainable land management are well incorporated into the National Action Plan of Thailand, which is under the coordination of the Land Development Department.

DS SLM Thailand Project Goals and Results according to the Decision Support Framework Modules:

Module 1:
Mainstreaming and scaling out of SLM technologies and approaches (ongoing work)

Expected Results:

- National and regional workshops on mainstreaming SLM into national policies and strategies organized in order to integrate findings and SLM strategies into decentralized, landscape planning, financing mechanisms, projects and local management plans.
- Partnerships with key institutions for scaling out best practices at decentralized levels.
- Indicators for monitoring progress and impacts in reversing DLDD and promoting adoption of SLM at landscape level (LDN Indicators).
- SLM Policy Briefs.
- National SLM Strategy

Module 2:
Capacity building of national technical staff on national and local level Land Degradation Assessment (LADA) and SLM tools and methodologies.

Results:
- A Five-day Training on National/Subnational Land Degradation Assessment (LADA) was held on 4 – 9 June 2018 in Bangkok, Petchaburi, and Ratchaburi provinces. A total of 76 participants from LDD staff (from Bangkok and regional offices), 13 other ministries and departments.

- An Eight-day Training on Local Level Land Degradation Assessment (LADA) Training Workshop was held on 23 – 30 July 2018 in Prachinburi, Chachoengsao Province. A total of 53 participants from LDD staff (from Bangkok and regional offices) plus national experts and international consultants trained.
- A Four-day Training Workshop (3-day training and 1-day field training) on WOCAT SLM Technologies and Approaches Questionnaires and Database was held on 6-9 August 2017 in Bangkok and Chachoengsao Province. A Follow-up Training of Trainers held involving all 12 Regional Offices experts of LDD.
- Development of adapted training modules from all of the above training sessions (in both English and Thai languages).
- The Completion of LUS map according results of Field Validation. Preparation of reports and visual materials of national/local assessments.

Module 3
The selection of Priority Landscapes **–** **"**hotspots**"** and **"**bright spots**"**

Results:

- Selection of two **(**2**)** hotspots and **(**2**)** brights pots according to the results of the LUS and QM**.**
- Selection of SLM Technologies and Approaches according to agreed criteria and documentation of 40 SLM (QA/QT) for publishing in the WOCAT website and Project Report.
- Selection of two (2) Demonstration Areas (one in hotspot and one in bright spot)
- Analysis report of findings, including institutional analysis at landscape Level for SLM Scaling Out Implementation from the Demonstration Areas.

Module 4 - Landscape Level Assessment

Results:

- Four Stakeholder awareness raising and consultation on SLM assessment and implementation at the Sub-Regional Levels with over 100 participants in each Sub-Region.
- Local review of selected technologies practices with the Stakeholders**.**
- Developed and disseminated knowledge products used for capacity building, including summaries of best practices, action plans, presentations, written documents, videos, etc
- National/sub-national ToT stakeholders workshops at national and landscape levels for farmers and extensions.

In-depth Local Level LADA & QM

- Conduct three (3) in depth Local Level Land Degradation Assessments (in three selected regions – north, north-east and central), in depth review and analysis for the final integrated national report in Thai and English**).**
- Establish demonstration sites implementation of scaling out of selected Approaches and Technologies in acid sulphate and saline soil problem areas (hotspot and brightspot).
- Develop SLM curriculum and conduct SLM training programme within the existing Volunteer Soil Doctors initiative

- Communications strategy (print promotional and communication materials, develop videos, documents presentation, exhibition, organize media tour, Global Soil Partnership awareness raising campaign on SLM, LD, LDN and other innovative SLM.
- Media tour and/or effective national awareness raising campaign on LD, LDN and innovative SLM.

Module 5 - SLM Territorial Planning (ongoing work)

Results:

- Constraints and needs for SLM strategies using SWOT analysis conducted to identify bottlenecks, gaps and opportunities and develop recommendations for adoption and scaling out of SLM building on the results of Module 4.
- Participatory land use planning outcomes with the selected communities in the selected sites. (possibly in the Nan Province)

Module 6 - SLM implementation and scaling out

Results:

- Partnerships for SLM implementation are operationalized and SLM best practices are implemented**.**
- SLM strategies with UNCCD National Action Program and within LDN target areas to scaling out best practices.
- Monitoring of technologies and land use/management systems through a training programme with the Volunteer Soil Doctors and farmer to farmer exchange visits.
- Conduct four to five priority thematic joint SLM state-of-the-art research aligned with the Thailand Soil Partnership pillars 1-3, including impact monitoring of Volunteer Soil Doctors (concept notes under preparation for the 4-5 research themes).