GIS AND REMOTE SENSING TECHNIQUES TO ESTIMATE THE SUITABLE PLACES FOR FARM PONDS ON AGRICULTURE IN TAMBON PA PO, THAILAND

[1]SUREEPORN KOADPRATUM, [2]TIEN YIN CHOU, [3]PI-HUI HUANG

[1]Ph.D. Program in Civil and Hydraulic Engineering, College of Construction and Development, Feng Chia University, Taiwan
[2,3]GIS Research Center, Feng Chia University, Taiwan
E-mail: [1]st_bo@ gis.tw, [2]jimmy@gis.tw, [3]pinky@gis.tw

Abstract - Tambon Pa Po is one sub district located on agriculture in rural area where farmers need water ponds developing in recent years. The objective of this study is to estimate and identify the suitable places for farm ponds on agriculture in Tambon Pa Po and give guidelines suitable places for farm ponds construction particular in drought area as where the problem of water and farmers have no enough water to use for agriculture and consuming purpose, preparing to keep water in ponds for agriculture or farm of farmers before rainy season coming is necessary. This study used structure of suitable areas and considered for a new place for pond by geospatial information using GIS and Remote sensing techniques. This useful technology as an instrument set to indicate suitable places for pond construction. Analysis used the thematic maps such as slope map, elevation map soil map, Land use map to identify the sites for ponds by assigning the weights to point feature in Tambon Pa Po, then calculating the suitability places for ponds is identified and indicated areas with MNDWI2 index water in different levels of suitability places for ponds with having potential area and available for the development of pond on farming area. The results of studying integrated map of water area form MNDWI2 and identified potential areas in water storage that showed 2.57% of suitable area is highly suitable for ponds, 0.11% of the area is suitable and 17.8% of the area is moderate, 36.53% of the area is low suitable and 36.53% is unsuitable. That result, of the study presented the estimate for pond suitable places also integrated map of water information area form MNDWI2 is used to guide storage of water for farm pond on agriculture landscape that led to better change in the selection of ponds for the farmer, MNDWI2 index integrated the suitable location for farm ponds would be used for pond construction and irrigation development.

Keywords - Farm Pond, Agriculture, Spatial Analysis, Suitable Places, MNDWI 2 .

I. INTRODUCTION

Water resource is important for agriculture region. Significance problem, particularly, in the northeastern of Thailand is drought, dehydration in the rainy season. Because most of areas are in the uplands with the soil could not absorb water, some areas do not have water to use and rely on only rain water. The limiting of water supply in the drought area that area is the most increasingly becoming face drought from climate change and long period of summer season with the temperature highly every year before rainy season coming particular in dry season. Tambon Pa Po is one sub district in Ban Phi district, Khon Kaen Province, Thailand. This sub district is located in an agricultural area in rural area with having water problem that has drought from soil and climate. Farmer is using water for farming nearly house and their farms, but have lacked of water and no enough water resource for agriculture in dry season and waiting for rain. This study section wants to designate a structure with indicate a suitable area for certain pond construction. Demand of farmers needed to use water enough for consuming in dry season until rainy. Pond construction is one the best ways to help farmer has and owner water resources on their farm, this idea for helping farmer in an agricultural landscape, a drought area in Thailand or having the same problem the other countries. An excellent GIS and Remote Sensing techniques can form simulating the truth on the earth's surface of information for achieving, access and decision the location of suitable area for the pond. How a technology so smart can actually help people and make clear of the questions. This study experimented and worked with focused on effective and importance criteria integrate with methods for water estimation using satellite image for determining the water storage, which used in this study and to recommended study of the area for pond on agriculture or farm that soil and landscape is the importance of considering to farm pond construction. There are many important aspects to consider when choosing a site for the implementation of a water harvesting scheme. Before selecting pond sites, first, it is important to make sure that the area meets certain physical characteristics. These characteristics include topography, drainage area, soil texture and land use. A good pond site contains (l) soil with sufficient clay to hold water and reduce seepage, (II) level topography that provides for economical construction and (III) an adequate runoff water supply [3]. According to selection of pond type [2] slope less than 5 % and slope greater than or equal to 5 % and 5-10% valley cross-sectional profile [8] also found that the area is intended to be located can be characterized by gentle slopes having less than 5% to minimize soil erosion and earth work for economical implementation. Global water governance has only emerged as a focus of study small farm ponds are important features in

many landscapes [6]. Conditions ponds have important water resource impacts through trapping sediments that otherwise would reduce downstream reservoir storage [9]. The spatiotemporal distribution of soil moisture is a key variable for hydrological and meteorological applications that influences the exchange of water [4]. Soil texture affects the backscattering coefficient by change in soil dielectric properties through its textural configuration in terms of its water-holding capacity [7]. Short-term agricultural drought and longer term hydrological drought have important ecological and socioeconomic impacts [13]. There are various methods for extraction of water information from remote sensing imagery which, according to the number of bands used [7]. The field of remote sensing of water extraction expanded greatly in various indices methods for water estimation using indices for determining the water storage. NDWI and MNDWI can better reflect the distribution of soil moisture conditions but the MNDWI with correction can effectively reduce the delay of response with the increase of vegetation coverage [5]. Small reservoir area engineered surface water bodies are estimated from MNDWI1 and MNDWI2 are more accurate than GSW and NDWI are similar, under all of the conditions tested in agricultural landscape. This knowledge can be used to inform decisions on future dam investments and surface water maps created in this study from Landsat8OLI imagery by computing the Normalized Difference Water Index (NDWI) and two variations of the Modified NDWI, which employ band 6 (MNDWI1) and band 7 (MNDWI2) as the short-wave infrared inputs was achieved using a threshold of−0.2 on both the NDWI and MNDWI1, and a 0 threshold on MNDWI2. This is partly the superior performance of MNDWI1 and MNDWI2 over very small reservoirs [11].

The aim of this study is to designate a structure with indicate a suitable area for certain pond construction and develop technique how to select and build up areas for farm pond on agriculture using technique of GIS and Remote Sensing, spatial analysis, identify areas for pond on the farm and serve framers need sustainable water resources for using in their own area and the government policy to reduce the problem of farmers during drought season. Hence, the study was worked out implementation of agriculture area landscapes are to estimate the location can be build up pond on farm for agriculture from satellite images using water indices and GIS techniques and to identify suitable places for farm pond construction.

II. DETAILS EXPERIMENTAL

2.1. Study Area

The study area, Tambon Pa Po is one sub district, Ban Phi district in Khon Kaen Province, Thailand. Tambon Pa Po lies between 15◦52’ 33.74’’ to 15◦ 58’ 30.16’’ North latitude and 102◦45’ 13.74’’ to 102◦50’ 36.28’’ East longitude is showed in Fig. 1.

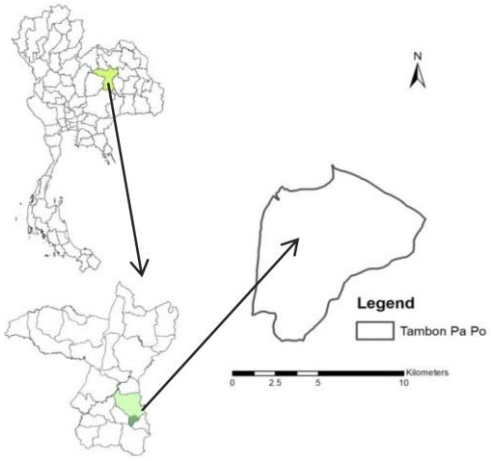


Fig.1.The location of the study area

This area is located in the drought area and the north east of Thailand where is located far from Ban Phi District to the southeast distance of 29 km. Tambon Pa Po covers an area according to the Ministry of Interior of 61.34 km^2 or 38337.50 rai with 11 villages. The total population of this sub district having around 7607 people and 1882 families. The topography of the area is hilly and plain with upland, a range of altitude of 190-235 m. The climate is generally hot and dry and average annual temperature is around 28°C. During the summer and winter of average temperature is about 36°C and 22°C. The rainfall average annual cover this area is around 1200 mm.

The most of areas in this study use of farming and agricultural area as e.g. rice sugar cane and cassava. For the adaptation of farmers living in drought season, the mango changed to be selected to plant in some this area. Famer has the main occupation is farming and the secondary occupation planting vegetables is some silk weaving, raising cattle and pigs, and planting vegetables.

2.2. Materials and Methodology

This study research on GIS and Remote Sensing to analysis and achieve the objective of this study, satellite imagery, thematic maps and DEM data are obtained from various organizations. The necessary data used in this experiment are as follows:

1. Satellite imagery of Lands at 8 is obtained from The United States of Geographical Survey (USGS) by downloaded at http://earthexplorer.usgs.gov
2. Soil series map, 2007 in 1:25000 is obtained from Land Development Department (LDD)
3. Land use map, 2017 in 1:50000 is obtained from Land Development Department (LDD)
4. Digital Elevation Model (DEM) of 5 meters is obtained from Thailand Ministry of Agriculture and Cooperatives (MOAC)

The experiment in this study, Arc GIS 10.5 and ERDAS IMAGINE 2015 software were used for analyzing. GIS and Remote Sensing technology are effective tools and useful to produce the thematic maps. DEM data were collected from MOAC had to mosaic for this study area before using ArcGIS10.5. Slope map was generated from DEM by using spatial analyst tools on surface option and derived slope map. Elevation map was generated elevation from DEM by 3D Analyst tools and then slope and elevation were classified into classified maps base on slope degree and elevation level class. Soil series map and land use map were obtained from LDD. The information on land use and soil types and textures were classified into the classified map. All of these criteria were classified into a suitable class map for analysis the suitable areas for pond construction. For Lands at 8 satellite imagery was acquired and downloaded from the website of the USGS that used in the dry season of this study on 16th April 2014. The preprocessing was begun with atmospheric correction by using ERDAS IMAGINE 2015 to reduce an effect and error of the image, e.g. noise by conversion of DN values to TOA reflectance before processing MNDWI2 analysis and extraction water by using the threshold of MNDWI2 image. MNDWI2 index, the potential was calculated by using (1) the equation of mathematic [11] as follows:

Band3-Band7/Band3+Band7 (1)

The MNDWI2 value significant information range from -1 to 1 can be extracted water and no water by the value of MNDWI2 threshold is shown in Table 1 The value greater than 0 means water before classifying image to assess the water area estimates derived from surface water map of MNDWI2 and the information that is water storage for pond on farm. The result of analysis is shown in Figure 2

MNDWI2 Value	Descriptions
-1-0	non water
>0	water

Table1. The values of MNDVI2 Threshold

All of the dataset maps in term of GIS environment are integrated by overlay technique in Arc GIS 10.5 to estimate the suitable places for pond construction. The factors were considered to estimate the suitable places for Farm ponds on agriculture in Tambon Pa Po are as follows:

1. Slope
2. Elevation
3. Soil
4. Land use
5. MNDWI2 index

Analysis was done to estimate the location can be build up pond on farm for agriculture from satellite images using water indices and identify suitable places for farm ponds on agriculture. All of the factors have to assign the weight age based on value of each information and suitability and then these weight age factors were integrated using Arc GIS software to identify the suitable places for farm ponds on agriculture in Tambon Pa Po.

Suitability level classified for farm pond suitable places have 5 levels, the value 5 indicates that it is highly suitable value 4 indicates that it is suitable value 3 indicates that it is moderately suitable value 2 indicates that it is low suitable and value 1 indicates that it is unsuitable shown in Table 7.

III. RESULTS AND DISCUSSION

There are aspects, selecting for an appropriate location. The major variable contributing in this experiment is slope, soil, land use, elevation including MNDWI2 to the selection of suitable sites is done by overlaying all these maps and the criteria assigned are based on categories of suitable classification.

An important factor in selecting pond sites is slope gradient, due to selection of pond type according to valley slope less than 5 % and slope greater than or equal to 5 % and 5-10% valley cross-sectional profile [2]. The slope map of the study area, which is procured from DEM was classified into five classes ranging from slope 0-2 % 2-5% 5-8% 8-10% and >10% which is shown in Table 2 and slope map of the study area is shown in Figure 3.

Slope (%)	Value
>10	1
8-10	2
5-8	3
2-5	4
0-2	5

Table2. Slope classification

Elevation is important factors in determining suitability for water ponds [14]. The study area shows a different category of slope ranging from 0-10, 10-30, and >30m. The results of the analysis according to elevation criteria shown in Table 3 and elevation map is shown in Figure 4.

Elevation (m.)	Value
0-10	5
10-30	3
>30	1

Table3. Elevation classification

The suitability of a pond site depends on the ability of the soil to hold water. Soils having clay or silt clay textures are excellent for ponds; sandy clays are satisfactory. Coarse-textured sand and sand-gravel mixtures do not hold water well and are unsuitable for ponds [2]. The table of classification for soil

suitable site is soil texture particle size class due to permeability based for soil suitability classification for farm pond in low land and up land [12] is shown in table 4. Soil series classification is shown in Table 5 and soil map is shown in Figure 5.

Soil series Name	Topography	Particle size class	Average Permeability	Permeability 1-2m., 3-4m. (cm./day)	Suitability classes
Nam Phong : Ng	Up land	Very Thick sand	High-very high	19.87-26.78, 3.77-5.04	Unsuit-able
Ban Phai : Bpi		Thick sand	Moderate-high	1.10-13.20, 1.36-2.65	marginal
Si Thon : St	Low land	Coarse loamy	moderate	1.90-2.07	moderate
Ubon : Ub		Thick sand	moderate	0.21-2.85	moderate

Table4. Soil suitability classification for farm pond in study area

Soil series name	Value
Nampong	1
Banpai, Mahasarakham	2
Sida, Si Thon, Ubon	3

Table5. Soil series classification

Land use	Value
Agriculture, Water bodies	5
Forest	2
Settlements, Built up land	1

Table6. Land use classification

Suitability	Value
Unsuitable	1
Low suitable	2
Moderately suitable	3
Suitable	4
Highly suitable	5

Table7. Suitable classification for farm pond

The land use map shows the spatial data extent of agriculture land including agriculture areas, built up land, forest , and water bodies of the study area [1], [10] is shown in Table 6land use map is shown in Figure 6.

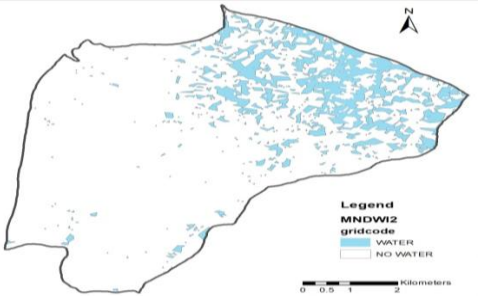


Fig.2. MNDWI2 map

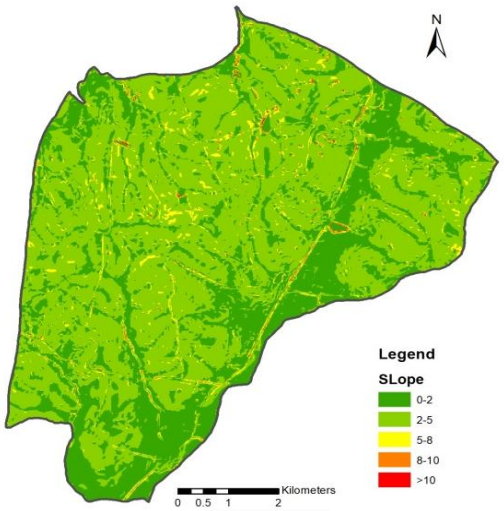


Fig.3. Slope map

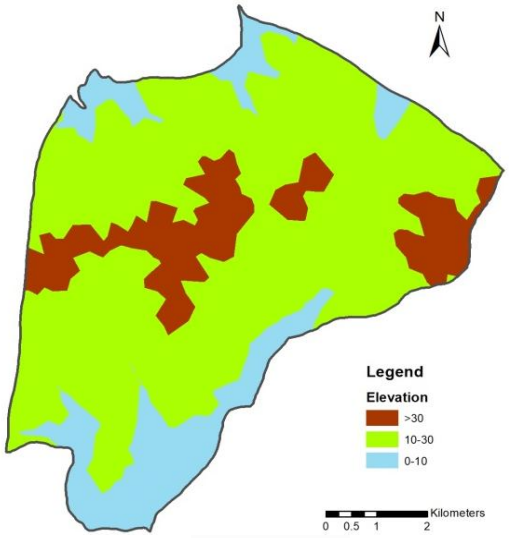


Fig.4. Elevation map

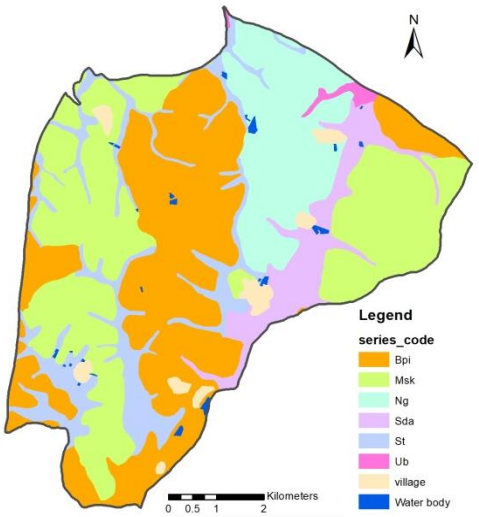


Fig.5. Soil texture map

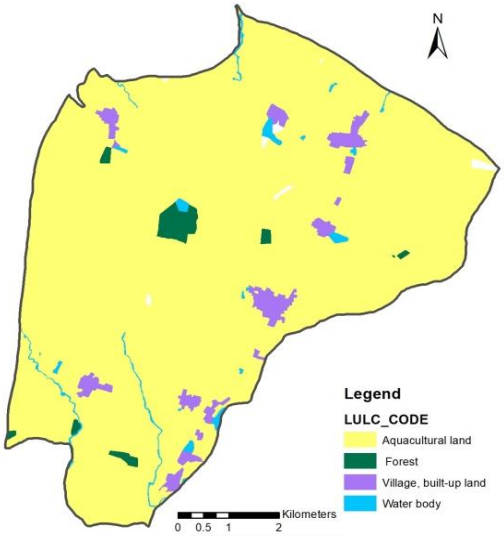


Fig.6. Land use map

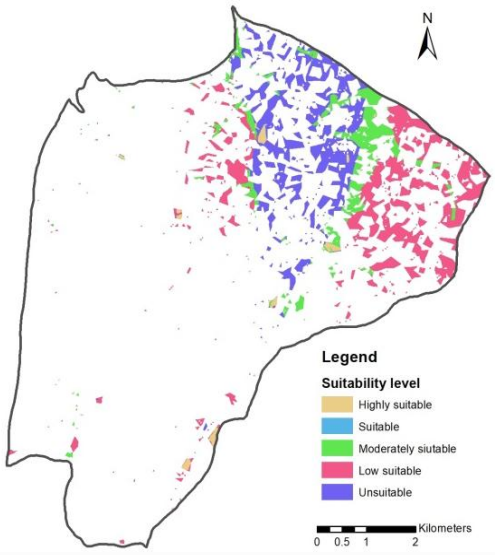


Fig.7. Integrated MNDWI2 and suitable places for farm pond

The suitable areas analysis for farm pond construction were identified using GIS by intersecting the required factor to form modeling in different layer and various factors including soil map, slope map, elevation map, and land use map of the study area. In order to verify the availability of MNDWI2 map of the study area is intersected with other parameters and selected suitable places of pond areas in water extraction is shown in Figure 7.

Suitable level	Area (m^2)	Area (%)
Highly suitable	204,978	2.57
Suitable	8,878	0.11
Moderate	1,417,908	17.80
Low suitable	3,422,915	49.98
Unsuitable	2,909,244	36.53

Table8. Percentage suitable areas of integrating map of MNDWI2 and suitable places for pond

The final results showed suitable places for farm pond in MNDWI2 indicated where have potential surface water storage areas in table 8 are presented that 2.57% of suitable area are highly suitable for ponds, 0.11% of the area is suitable and 17.8% of the area is moderate, 36.53% of the area is low suitable and 36.53% are unsuitable. That's the result of the study showed the estimate for farm pond suitable places also integrated map of water information area form MNDWI2 is used to guide storage of water for pond rely on rain in drought area of the agricultural landscape. If factor of the soil in unsuitable suggested necessary checking before pond construction. The verification of the suitable place can be improved by combining data with pond survey and checking by ground truth. A further step of study with the good result responding indicated by point of exiting pond overlay on a suitable place for farm ponds include the level of water inside of the meaning.

IV. CONCLUSIONS

The suitable places for farm ponds in agricultural landscape in Tambon Pa Po is done by analysis using the overlay technique that provided the efficient tools of GIS and Remote Sensing. The main point of the study is estimated the location can be build up pond on the farm and identify suitable places by important criteria of soil, land use and topography as slope elevation including MNDWI2 information to site selection for pond suitable area. This study revealed the result of suitable areas for pond construction and use MNDWI2 index help to guideline which combine with one idea. However, for the implementation need intensively to study for the new places for pond construction in the other areas.

The main result of study introduced a new measurement technique of considering the water storage as MNDWI2 need to be considered concerns with landscape of topography e.g. slope gradient, elevation in agricultural landscape before the expansion of ponds and have focused on soil at large scales. For further analysis of studies confirm to recommend the factors of designing a farm pond

structure such as road, river and alternates criteria are necessary should be integrated with analysis, environmental of farm pond construction in the future as well. The point of view in this study function of analysis suitable pond of this experiment is very useful for study, which can use to assign and estimate new suitable places for pond construction. The authors believe this study would be helping farmers and the government support to earn that very well in the perfect policy of farm pond irrigation for water resources development on agricultural planning.

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