ISBN 978-81-934174-9-2
8th International Conference on Disaster Management, Building Design, Materials and Civil Engineering (DBMCE-17)
Bangkok (Thailand) Dec. 25-26, 2017

The Potential Surface Analysis (PSA) for Groundwater: A Case Study of Chainat Province, Thailand

Natchaya Surasingkaisorn [1], Pechrida Pechkong [1], Weerakaset Suanpaka [1], Hiroaki Shirakawa [2]

[1] Dept. of Civil Engineering, Kasetsart University, Bangkok, Thailand
[2] Dept. of Urban Environment, Nagoya University, Nagoya, Japan
Email: surasing.fee@gmail.com

***Abstract*:** *Water is essential for human beings, animals, and living organisms. Nowadays, the rate of increasing water consumption as a result of increasing global population and the expansion of industrial sectors, as well as the use of water in agriculture. Groundwater is water that stores beneath Earth's surface. The most of groundwater can be found at the cracks of the rock, and gap between gravel pits and sand grains deep underground. This paper explains to refine groundwater by using GIS techniques for a study area at cause Chainat province. The GIS techniques have been used potential surface analysis. The impact of groundwater is soil type, area 1km from the main river, elevation, and water body. The results showed the probability of groundwater in a study area could be used to developing the effect of drought, the scenario of future water consumption from human, agriculture, and industry. Some areas may require the use of groundwater because of a shortage of surface water.*

Keywords: *Groundwater, Disaster, GIS, PSA*

1. Introduction

Water is a compound found three-quarters part of the earth. Most of them are saline in the sea and oceans, about 97 percent, ice polar about 2 percent and fresh water in the river or the lake about 1 percent. If the world is free of water, the living organism on the earth cannot live. The number of water on the earth is large and underground, air and everywhere on earth. Nowadays, water is important to humans and organisms, so water is the main factor in human life. Humans have a great deal of water consumption, both agriculture and industry sector. As a result, there is insufficient water with consumption. However, human are still finding another source of water to help replace the water is not enough or finding the route in analyzing groundwater to assist in agriculture sector from the drought situation such in the study area.

There are many countries face large losses from extreme natural hazards. Regarding droughts, planning instruments are significant for managing water resources and diminution the losses. Thailand has faced drought situations almost every year, including the current one. According to data from the Land Development Department, areas of permanent droughts in Thailand still covers as much as 40% of total agricultural areas. Since there was insufficient rainfall in many years ago, which lead to yields have fallen, affecting the volume reduction that will be harvested. In 2015 - 2016, the value of economic damage in Thailand by total damage to agricultural land was 2.87 million rai with the yield of 6,101,050.38 tons, total damage was 15,514.65 million baht. (Teerayut Thaiturapaisan, 2016). However, the implementation of solving the drought has many routes, but this paper about developing water from the chance of discovering groundwater has been remarkable.

2. Study Area

Thailand is a small country in Southeast Asia that there is quite a serious problem about disasters in many areas. This paper was conducted in the sample area at Chainat Province. Chainat Province is located in the central part of the country. It is located on the left bank of the Chao Phraya River and is the northernmost part of central Thailand. The latitude is 15 degrees north and the longitude is 100 degrees east, high from the average sea level 16.854 meters, with an area of about 2,469.746 square kilometers with the terrain. Generally, the area is flat with an area of about 99.06 of the total area. (Office of the Treasury Chai Nat, 2014) Furthermore, the terrain is flat that a small hill about 1 - 3 miles spread over the area. Chainat province is an area with low rainfall, so it is quite a drought. Average rainfall throughout the year is 1,000-2,000 millimetres. The average annual temperature is 27.8 ° C with the hottest weather in April and May. Maximum temperature is 41.6 ° C and minimum temperature is 8.3 ° C. Nowadays, Chainat province has a population of 333,183, of which 160,859 males and 172,324 females and divided an administrative region into 8 districts (Mueang Chainat, Manorom, Wat Sing, Sapphaya, Sankhaburi, Hankha, Nong Mamong and Noen Kham). The most area of Chainat province are river basin, as a result, it is suitable for agricultural occupation. The majority of the population is about 80 percent of them working in agriculture. It is also a major agricultural area of the country. (The government office of Chainat Province, 2017)

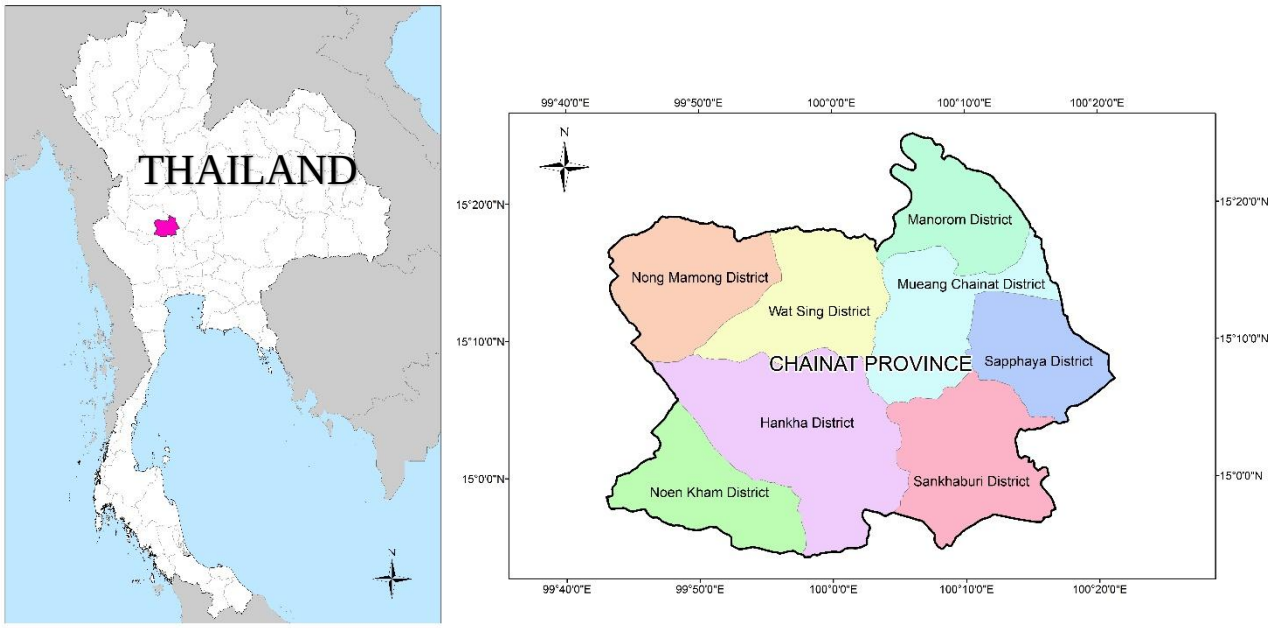

Figure 1-2: Location map of case study area

3. Methodology

3.1. Potential Surface Analysis (PSA)

Techniques for Spatial Potential Analysis Using the PSA Method is an analytical method using one linear equation. This technique was invented to analyze the potential of space development for using appropriate space in the future. It is a way to transform the area from shown pictures into numbers which using analytical techniques by Sieve Analysis, but there is an increase in mathematical value in different areas systematically.(Sura Pattanakiat, 2003). The process of PSA analysis consists of the following steps.

3.1.1. Selection of Relevant Factors

Based on the main factors involved such as the study of the potential of land use for development as a residential area is based on the factors that affect physical. These include slopes and public utility various factor.

3.1.2. Spatial Data Preparation

The information in the form of a map with the details and appropriate sections that should be the same data. It also necessary to be monitored and correct the data to be correct before applying it.

3.1.3. Data Input and Storage in GIS Format

It is the management of the data in the form of a raster or vector structure as required.

3.1.4. GIS Data Analysis

3.1.4.1. Rating Value is the level of correlation of the components or sub-factors of the main factor which determine the value of unrelated factors or no potential value for zero. The least value starts with one, and so on up to the most relevant.

3.1.4.2. Weighting Value is adjusting the value of every factor to the same range (0 - 1), then give the weight of each factor. The weighting criteria of each factor will be important. If it is of minor importance, it will be low and the weighting will have to be higher than zero.

3.1.4.3. Data Manipulation is calculate the results using the appropriate equation or potential. The formula is as follows.

$$\text{Suitability (S)} = (R1 \times W1) + (R2 \times W2) + \ldots + (Rn \times Wn) \quad (1)$$

R = The value of each factor in the overlapping area.
W = The weight of each factor used in the average.
n = Number of factors used in the analysis.

3.1.4.4. Data Presentation is results of the calculation are grouped into groups and presented as a map showing the potential of the area. (Supitcha Dhanarun, 2009)

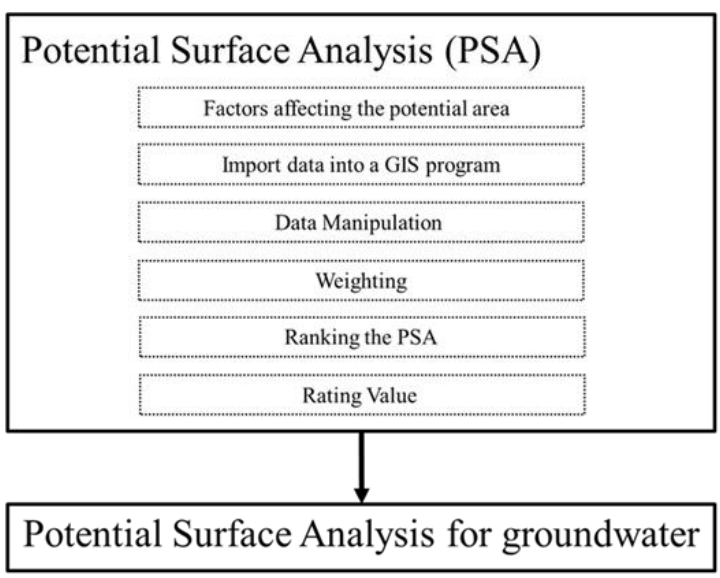

Fig. 3: The process of potential surface analysis (PSA)

3.2. Work Diagram

The parameters used to determine chance to discover groundwater in the study area. The four parameters classifications are then given appropriate weight to its role in causing groundwater. Processing is done by using ArcGIS software in order to provide an overview Potential Surface Analysis (PSA). (Nur Hafizul Kalam1 & Ima Rahmawati, 2015).

Weight for each factor

- Main-river (1,000 m buffer of main-river)
- Bodywater
- Elevation
- Soil type

The formula used to add index factors:

$$\text{PSA} = (\text{Main-river}) + (\text{Bodywater}) + (\text{Elevation}) + (\text{Soil type}) \tag{2}$$

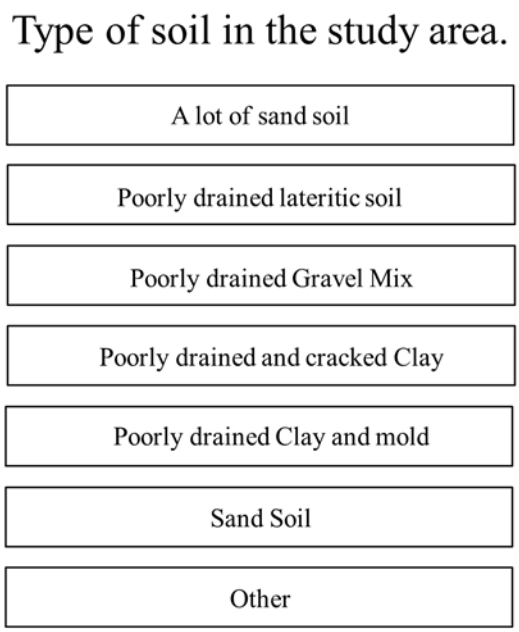

Fig. 4: Factor of soil types

3.3. Concept Analysis

The concept analysis of this study based on the data analysis methods. By extract, the information from Landsat8 data then comprises with the existing GIS data to generate PSA variables. (Suvalak N, Supaporn Kaewko L, Lertwit R, 2007). Fig 5 is simply illustrated the concept.

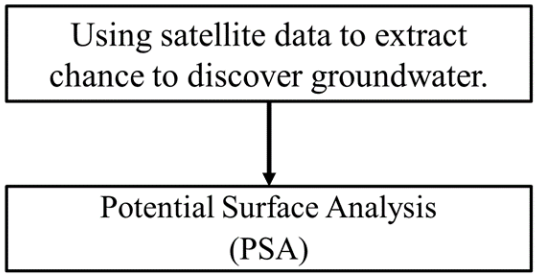

Fig. 5: Concept analysis

4. Results

The result shows potential surface of groundwater in Chainat province which has 2,469.746 sq.km of area. The probability and levels of groundwater have been shown in Figure 6 and 7, respectively. Moreover, the table 1 present chance of groundwater detection in each district is divided into 4 categories in whole 8 different district are low, medium, high and very high.

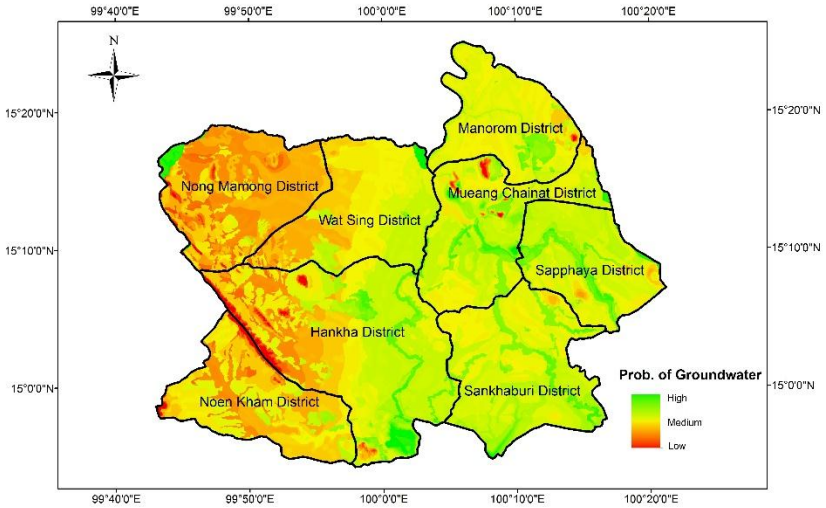

Fig. 6: The result map shows probability of groundwater in Chainat province

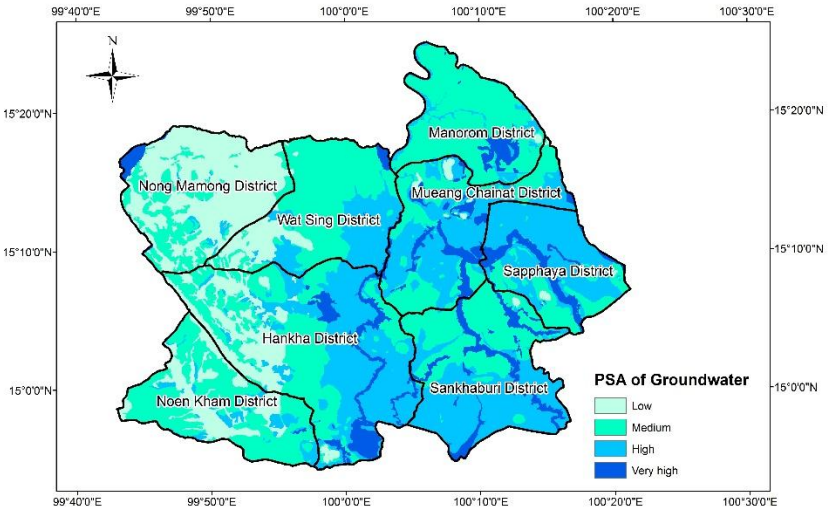

Fig. 7: The map shows different level of Potential Surface of groundwater

This study found that chance of groundwater detection in chainat province for the low category is 440.309 sq.km (17.828 percent), the medium is 1046.368 sq.km (42.367 percent), the high is 776.260 sq.km (31.431 percent) and the very high is 206.808 sq.km (8.374 percent). There is a total area of 4 categories is 2,469.746 sq.km.

TABLE 1: The areas of Potential Surface Analysis

District	Low		Medium		High		Very high	
	Km^2	%	Km^2	%	Km^2	%	Km^2	%
Hankha	94.800	3.838	181.683	7.356	209.785	8.494	54.137	2.192
Manorom	1.331	0.054	182.872	7.405	21.281	0.862	20.603	0.834
Muang Chainat	7.008	0.284	105.579	4.275	133.934	5.423	38.190	1.546
Sankhaburi	1.040	0.042	129.034	5.225	162.862	6.594	46.117	1.867
Wat Sing	2.514	0.102	49.853	2.019	140.302	5.681	30.118	1.219
Sapphaya	42.494	1.721	167.367	6.777	76.730	3.107	6.840	0.277
Noen Kham	73.471	2.975	156.906	6.353	26.567	1.076	0.685	0.028
Nong Mamong	217.650	8.813	73.074	2.959	4.797	0.194	10.117	0.410
Total	440.309	17.828	1046.368	42.367	776.260	31.431	206.808	8.374

5. Conclusion

The scenario of groundwater results is analyzed by using the potential surface analysis (PSA) method. It can be developed water allocation for various areas which can calculate the chance of groundwater detection in order to plan to solve the drought area. This problem is the greatest impact on Thailand agriculture because Thailand is an agricultural country frequently effected drought disaster. Therefore, there should be the way for finding a solution to this problem with the efficient management plan. In addition, more agriculture development plan in this study area along, in form of chance of groundwater detection, has been remarked.

6. References

[1] Teerayut Thaiturapaisan. (2016). Thailand's drought crisis 2016: Understanding it without the panic. (Online). Available : https://www.scbeic.com/en/detail/product/2127 [2017, April 2]

[2] Office of the Treasury Chai Nat. (2014). Basic Information of Chainat Province (Online). Available : http://www.treasury.go.th [2017, March 25]

[3] The government office of Chainat Province. (2017). **Information of Chainat Province.** (ed. Super User) Pp.1-8. Chainat Province: Chainat Provincial Office.

[4] Sura Pattanakiat. (2003). **Geo-Informatic System in ecology and environment.** Bangkok: United Produce Printing Limited Partnership.

[5] Supitcha Dhanarun. (2009). **Application of Geographic Information System for Flood Risk Area Assessment in Angthong Province.** Master of Science. Dissertation, National Institute of Development Administration.

[6] Nur Hafizul Kalam & Ima Rahmawati.(2015). Identification of Potential Landslide Using Remote Sensing and Geographic Information System in Upstream of Kayangan Watershed, Kulonprogo Regency, Indonesia. Proceedings of 2015 International Conference on Disaster Management in Civil Engineering. Phuket, Thailand, October 1-3, 2015, pp. 33-38

[7] Suvalak NAKYA, Supaporn Kaewko LEOPAIROJNA, Lertwit RANGSIRAKSA. (2007). Use of Satellite Data and Potential Surface Analysis for Urban Expansion of Hua Hin Municipality, Prachuap Khiri Khan Province, THAILAND. 120 The Government Complex Commemorating His Majesty The King's 80 th Birthday Anniversary, 5th December, B.E.2550 (2007).