Land Subsidence Prediction in Central Plain of Thailand

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Abstract—The aim of this research was to analyze risk areas of land subsidence. Risk factors were selected from related research on the problem of land subsidence. There were six factors selected: geological, hydrogeological, number of wells, groundwater used, land use and amount of population. The factors were analyzed by weighting and rating scores from twelve governmental officers from concerned agencies. The total score of each factor was employed to assess risk area of land subsidence by GIS and PCA method. The output in this study is a map of risk area of land subsidence in Nakhon Pathom Province, representative central plain area. In this study, the risk area of land subsidence was classified into 3 levels. Most of the land consisted of areas at a moderate risk of subsidence and these areas were scattered throughout the study area, covering 1,905.93 km², while a high level risk areas was found in parts of the west and south of the study area, covering 251.02 km². The low level of land subsidence risk covered the least area, at only 14 km², mainly in the northwestern and eastern parts of the study area. Furthermore, the results showed land subsidence is most heavily influenced by excessive utilization of groundwater. The second most influential factor is the number of wells. A comparison of bench marks from the Royal Thai Survey Department, ground checks of the real situation and the assessments made in this study showed all.

Index Terms—Land subsidence, central plain of Thailand, GIS, PCA.

I. INTRODUCTION

A number of phenomenon factors account for land subsidence in has been attributed to: 1) loading of a land surface, 2) vibrations at or near the land surface, 3) compaction due to irrigation, 4) solution due to irrigation, 5) drying and shrinkage of deposits, 6) oxidation of organic materials, 7) decline of the water table, 8) decline of artesian pressure in water sands, 9) decline of pressure in oil zones due to the removal of oil and gas, and 10) tectonic movement [1]. Spatial variation in geological, ground water, geomorphological, soil and vegetation characteristics can distribute to diversity of landform [2]. The nature and intensity of land subsidence are therefore likely to be highly dependent on the physical context (geological, hydrogeological, well location, groundwater use, land use) and amount of population and also the level of problem varies by difference factors [3].

Thailand, land subsidence is crisis problems which occur to central plain region as especially economic area [4]. The major cause of this problem comes from over pumping groundwater, since people have problems with lack of water supply in household and industrial sectors [5] [6]. Demand for water to groundwater pumping increases every year, this event resulted in the land subsidence [7]. Central Plain of Thailand got the land subsidence as high rate around 10 cm/ per year [8]. Nakhon Pathom, one main province in the central plain of Thailand with the total area of 2,170.96 km². Nakhon Pathom province is divided into 7 Districts such as Mueang, Khamphaengsaen, Dontum, Nakhon Chai Si, Bang Len, Sam Phran and Putthamonthon. In order to keep central plain representation, this paper selects Nakhon Pathom, province study area. Based on Geographic Information System (GIS) and collected data, the effected factors of land subsidence are discussed combining with Principal Components Analysis (PCA) method.

II. METHODOLOGY

A. Choosing Factors

Considering the six factors including geological, hydrogeological, amount of well, groundwater use, land use and amount of population [9]-[11]. In 2005, we work in the field to survey the overall condition of studied area exploring the bench mark of Royal Thai survey Dept. and exiting land use and wells characteristic. The other data are collected by literature, statistical annual and referring data.

B. Data Analysis

The data was analyzed by GIS [12] and PCA method. We use questionnaire for asking the 12 environmental officers (from Dept. of Groundwater Resources and Dept. of Mineral Resources). They were generated weighting score by comparing on importance of each factor that appropriate and importance on prediction the risk of land subsidence. At the same time the environmental officers analyzed each factor first and mark the score on the range from 1-5 according to the suitable factors within the same group. GIS and PCA method combined together by below equation (1)

\[ S = W_1R_1 + W_2R_2 + W_3R_3 + \ldots + W_nR_n \]  (1)

where

- \( S \) = risk level of land subsidence
- \( W_1 \) to \( W_n \) = weighting of each factor
- \( R_1 \) to \( R_n \) = score of sub factor from 1 to n
- 1 to n = effective factors

III. RESULTS

Quaternary sediment of tidal-dominated deposits, flood plain aquifers, lower than 20 wells, lower than 300 m³/hr. of groundwater Use, Agriculture area and lower than 7,000 amount of people were the majority characteristics of the area. The detail was shown in Table I.

The approval and weighting values gained from these persons would be analyzed further for finding forecasting model for risk of land subsidence. Frequency of weighting

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